SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1906.

GENERAL PHYSICS.

652. *Helme's Instrument for Surveying Deep Bore-holes.* **J. B. Porter.** (Page's Weekly, 8. pp. 86–88, Jan. 12, 1906. Paper read before the Canadian Soc. Civ. Engin.)—Sometimes the departure from line, in holes about 1,000 ft. deep, exceeds 10 per cent., and one way of surveying the hole involves the use of a plummet and compass needle immersed in paraffin wax, which is melted by an electric current and then allowed to solidify. Helme's apparatus, which can be lowered on the end of a piece of flexible wire, contains compass, plummet, small cameras, and a dry battery, the whole being connected with a small adjustable clock so that electric light can be turned on for a given period after the apparatus has been lowered into the hole. A sensitised disc is carried below the plummet on a plate suspended on gimbals, and another disc is placed on the dial of the compass. The photographs of the plumb-bob and compass needle, taken at different depths, furnish data from which the path taken by the bore-hole can be plotted in plan and section. G. E. A.

653. *Photographically recording the Movements of Tuning-forks, Meteorographs, &c.* **R. Nimführ.** (Ann. d. Physik, 19. 3. pp. 647–648, March 2, 1906.)—The author employs sensitised photographic paper, and covers this, when placed on the recording drum, &c., with a uniform layer of soot by means of a paraffin lamp. The record is then obtained on this sheet, which latter is afterwards exposed to the sun or daylight. The soot is then washed off and the paper placed in a fixing bath. The records so obtained—brown-black lines on a white ground—are of great delicacy, the finest lines being reproduced. L. H. W.

654. *Effect of Temperature, Vibration, &c., on Friction.* **A. Pacinotti.** (Accad. Lincei, Atti, 15. pp. 82–89, Jan. 21, 1906.)—The author has studied the effect of temperature, vibration, humidity, electrolysis, and greasiness upon the friction and adhesion between various substances. The inclined-plane method is chiefly employed, but in some cases the force required to drag the body along a horizontal plane is used. In most cases the effect of rise of temperature is to decrease the friction between bodies, but in a few cases the author finds the reverse to be the case, *e.g.*, polished iron

($f = \tan 13° 30' = 0{\cdot}24$ at atmospheric temperature ; $f = \tan 23° 10' = 0{\cdot}4279$ at 390° C.), platinum on platinum, &c. The angle at which a body will be at rest on a brass rod is diminished very much when the rod is stroked so as to produce a slight sound. In investigating the effect of moisture it is found that adhesion plays an important part, and in this case the body is pulled along a horizontal plane. Then $Pf + Se\lambda = R$, where R is the resistance to motion, P the weight, f and λ the coefficients of friction and adhesion, and e the fraction of the surface S, which is in true contrast. By making several experiments f and $e\lambda$ are found. The results with several moist earths and clays in contact with metals are given. S. G. S.

655. *Tensile Overstrain and Recovery of Aluminium, Copper, and Aluminium Bronze.* **A. Morley** and **G. A. Tomlinson.** (Phil. Mag. 11. pp. 380–392, March, 1906.)—The authors give details of experiments on these metals corresponding to those of Ewing and Muir on iron and steel. After overstrain aluminium recovered its elasticity with lapse of time, the recovery being almost complete after 14 days' rest. Recovery was achieved at a quicker rate by immersing in water at 99° C. for 3 min., but after 14 days was not so complete as in the unheated specimen. Copper gave practically the same results immediately after as before overstrain—showing that if the properties were altered at all by overstrain, recovery was very rapid. In the case of aluminium bronze (Al plus 10 per cent. Cu) the rate of recovery with lapse of time was slow, but with moderate heat it was very rapid. The effect of mechanical vibration on overstrained aluminium was inappreciable, but with aluminium bronze vibration enhanced the effects of overstrain and retarded recovery. F. R.

656. *Velocity of Gas in Tubes.* **R. Burnham.** (Eng. News, 54. pp. 660–662, Dec. 21, 1905. Bull. Soc. d'Encouragement, 108. pp. 136–137, Jan., 1906.) —The paper gives a description of the use of a Pitot tube for determining the velocity of gas. The tubes used consist of two L-shaped, concentric brass tubes, one 4·7 mm. external diam. and 0·8 mm. thick, the other 9·5 mm. external diam. and 0·8 mm. thick, in the shorter limb of which is a slit 4·7 mm. wide and 32 mm. long. The long branch is fitted through the side of the tube (600 mm. diam.), along which the gas flows, a stuffing-box allowing the Pitot tube to be turned through any angle, the orientation being given by a pointer. The space between the two tubes is, at the end of the short limb, filled up, the end of the inner tube being open, pressure being communicated to the air in the outer tube through the slit. The pressure in the two tubes is measured by two sensitive petrol manometers. The tube along which the gas flows is in communication with two large gasometers, between which 480 cub. m. of air can be passed per min. The mean velocity along the tube is measured by the fall in the smaller of these, which had been previously calibrated. Two Pitot tubes are used, with thermometers giving the temperature of the gas. To deduce the mean velocity from the velocities at different points of the tube a graphical method is adopted, and the value obtained agrees well with that given by the gasometer. A curve is given from the author's results with velocities varying from 10·5 to 19·5 m. per sec. The results agree well with those obtained by Threlfall in 1904. A. W.

657. *Motion within an Elastic Medium due to a Point Disturbance.* **J. Boussinesq.** (Comptes Rendus, 142. pp. 480–485, Feb. 26, 1906.)—Poisson has shown that the disturbance of a point within a homogeneous and isotropic elastic medium causes the propagation of two spherical waves from this point with different velocities, one with longitudinal vibrations and the other with transversal. Ostrogradsky showed that the interval between the waves remains in motion till the slower wave has passed, and the author now shows that this motion in the interval vanishes only if the particles move uniformly in different directions but with displacements and velocities whose orders of magnitude are inversely as the squares and cubes respectively of the distance from the centre of disturbance. R. E. B.

658. *Surface Tension by Method of Liquid Jets.* **F. R. Watson.** (Phys. Rev. 21. pp. 59–62, July, 1905. Abstract of paper read before the Amer. Phys. Soc., April 22, 1905.)—The jet issues horizontally from a nearly circular orifice, and the scale and jet are optically projected on to a screen, the magnification being about 20. The surface tension is calculated by Rayleigh's formula, the wave-length of the oscillation being measured directly on the scale. The experiment was arranged to last a short time, so that the head of liquid did not change appreciably while the observations were being made. The result obtained for water is 70 dynes per cm., while that for mercury varied from 527 to 495. For mercury wet with water the result is the same; it is possible that the mercury was wet in all the experiments. S. G. S.

659. *Coefficient of Viscosity of Air at Low Temperatures.* **S. Chella.** (Accad. Lincei, Atti, 15. pp. 119–125, Jan. 21, 1906.)—The apparatus previously described [see Abstract No. 1848 (1905)] is cooled by means of liquid air, and determinations of the coefficient of viscosity by means of the vibrating cylinders are made at temperatures ranging from + 18° to − 145°. The results of several experiments are given and are fairly in accord. From curves exhibiting these experimental results and those calculated from the parabolic formula it is evident that the observed are much less than the calculated values. The author shows that this would be expected according to the kinetic theory, for, as the temperature falls the diam. of the molecule becomes a larger fraction of its mean free path. S. G. S.

660. *Particular Case of the Problem of* n*-Bodies.* **T. Banachiewicz.** (Comptes Rendus, 142. pp. 510–512, Feb. 26, 1906.)—A particular solution of the problem of 3 bodies, the attraction between which is inversely as the *cubes* of the distances separating them is the following: If the masses m_1 ... are initially at $(a_1, b_1, 0)$ ... and the relations $\Sigma ma = \Sigma mb = \Sigma mab = \Sigma mab/\rho^4 = 0$ hold, where ρ_1 denotes the initial distance between m_2 and m_3, &c., then the equations of motion being $m_1\ddot{x}_1 = m_1 m_2(x_2 - x_1)/r_3^4 + m_1 m_3(x_3 - x_1)/r_2^4$, &c., a solution is—

$$x_1/a_1 = x_2/a_2 = x_3/a_3 = \tau, \quad y_1/b_1 = y_2/b_2 = y_3/b_3 = \tau\cos\theta, \quad z_1/b_1 = z_2/b_2 = z_3/b_3 = \tau\sin\theta,$$

where—

$$\tau \equiv \sqrt{[(1 + \alpha t)(1 + \beta t)]} \text{ and } \theta \equiv \gamma \log[(1 + \alpha t)/(1 + \beta t)],$$

with—

$$(\alpha - \beta)^2 \equiv 4\Sigma m\rho^4 \Sigma ma^2/\Pi\rho^4 \Sigma ma^2/\rho^4, \quad 1 + 4\gamma^2 \equiv \Sigma mb^2 \Sigma ma^2/\rho^4/\Sigma ma^2 \Sigma mb^2/\rho^4.$$

This is an important case, for the orbits of the particles are—differently from other known cases—curves of *double curvature*: these lie on the cones $y^2 + x^2 = (b_1/a_1)^2 x^2$, &c., which have the x-axis for their axis and $\tan^{-1}(b_1/a_1)$,...

for their semi-vertical angles. The centre of mass of the particles is always at the origin, and the triangle connecting the particles is always similar to itself (since $r/\rho = r$), and lies in the plane $y/z = \tan\theta$, which passes through the x-axis and rotates about it with the angular velocity $\gamma(\alpha - \beta)/r^2$. [The notation has been simplified for convenience.] R. E. B.

661. *Condensation Nuclei.* **C. Barus.** (Phys. Rev. 22. pp. 82–110, Feb., 1906. Presidential Address before the Amer. Phys. Soc., Dec. 30, 1905.)—A summary of the author's work on this subject is given. He regards as the most important outcome of the researches the appearances indicating that a gas, or at least a moist gas, far from being a uniform system, behaves like an assemblage of nuclei, which decrease in size and increase in number as the molecular dimension is approached. Every group of nuclei is none the less a structurally essential part of the gas, and (be the number of groups few or many) at once restored if withdrawn; while the molecule itself is distinguished among the many nuclei of its own kind by the maximum frequency of occurrence. [See Abstracts Nos. 986 and 1340 (1905) and 14 (1906).] J. J. S.

662. *Measurement of Gravity by Bending.* **M. Brillouin.** (Verhandl. der 14. allgem. Konf. d. Intern. Erdmessung. Ann. Bd. 21. Part 2, p. 456, Berlin, 1905. Zeitschr. Instrumentenk. 26. pp. 59–60, Feb., 1906. Abstract.) —A plate of crystalline quartz, $\frac{1}{3}$ mm. thick, 5 mm. broad, and 52 mm. long, is clamped at one end and loaded with 5 gm. at the other. The bending produced, if estimated to an accuracy of 0·3″, gives g to an accuracy of a two-thousandth per cent. The angle of bend is determined by an optical method which depends on the double refraction produced by quartz, and if the plate is fixed the desired accuracy is obtained with a single reading; not so when the plate is free unless the vibrations have been well damped, which with special arrangements can be done in 15 min. The influence of temperature and elastic reaction on the instrument have not yet been sufficiently studied, but the former seems to be of the order 6″ per degree. R. E. B.

663. *Pressure and Temperature of Air in Motion.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1271–1292, Oct., 1905.)—If air is in motion with velocity u, a barometer and thermometer carried along with it will indicate the pressure $\frac{1}{3}\rho c^2$ and absolute temperature $c^2/3R$ due to its mean-square velocity c: but if they are placed just in front of or just behind a fixed screen perpendicular to the direction of flow, their readings will, on the kinetic theory, rise or fall by a fraction which may be as great as $3u^2/c^2$; this for $u = 20$ m. per sec. would mean about 3·8 mm., or 1·4° C. This theory is used to explain the meteorological conditions in the wedge of high pressure to the north of the Alps, Montigny's barometric observations at various heights and azimuths on the tower of Antwerp Cathedral, Mazelle's temperature-observations during the times of Bora at Trieste, and Hann's studies of the Föhn at Altdorf and Bludenz, mountains forming variously shaped screens in most of these instances. It is further pointed out that the gradient $\partial p/\partial h$ is measured by $\partial b/\partial h$ only if $\partial(\rho u^2)/\partial x = 0$, p and b being the pressure and the barometric height at any place at the elevation h. R. E. B.

664. *New Determination of Molecular Dimensions.* **A. Einstein.** (Ann. d. Physik, 19. 2. pp. 289–306, Feb. 8, 1906.)—This determination of the order of the molecular dimensions is derived from the properties of solutions, the

points considered being viscosity, osmotic pressure, and diffusion-coefficient. It is shown that if n dissolved molecules of radius P occur in the unit volume of the solution, the viscosity is given by—

$$k'/k = 1 + n\,.\,(4/3)\pi P^3, \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where k' is the coefficient of viscosity of the solution, and k that of the pure solvent, the molecules being treated as spheres. Let m be the molecular weight of the dissolved substance, ρ the number of grammes of it in 1 c.cm. of the solution, N the number of molecules in a gm.-molecule. Then $n/N = \rho/m$, thus (1) becomes—

$$NP^3 = (3m/4\pi\rho)\,(k'/k - 1) \quad\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

The equations of motion of a molecule, driven by the osmotic pressure and checked by the viscosity, are then considered. The velocity was shown by G. Kirchhoff to be given by—

$$\omega = K/6\pi kP, \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where K is the impressed force. But we have—

$$K = (-\,m/\rho N)\,\partial p/\partial x, \quad\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where p is the osmotic pressure given by—

$$p = (R/m)\rho\,T, \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

T being the absolute temperature and $R = 8{\cdot}31 \times 10^7$. Equations (3), (4), and (5) yield—

$$\omega\rho = (-\,RT/6\pi k)(1/NP)\partial\rho/\partial x. \quad\ldots\ldots\ldots\ldots(6)$$

Hence, introducing the diffusion-coefficient D, we have—

$$D = RT/6\pi k\,.\,1/NP \text{ or } NP = RT/6\pi k\,.\,1/D \quad\ldots\ldots(7)$$

From (2) and (7), giving NP^3 and NP, we have both N and P, the latter being the radius of the molecule treated as a sphere. Taking the case of sugar dissolved in water the author finds $N = 4.15 \times 10^{23}$ and $P = 0.78.10^{-6}$ mm.

E. H. B.

665. *Distribution of Solar Radiation on the Earth.* **F. Hopfner.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1315–1357, Oct., 1905.)—The heat received per unit area per unit time at a place of latitude ϕ is $Cr^{-2}\cos z = Cr^{-2}(\sin\phi\sin\delta + \cos\phi\cos\delta\cos\tau)$, where C is the radiation-constant, and r, z, δ, τ are the sun's distance, zenith distance, declination, and hour-angle respectively. Two modes of integrating this expression in terms of the time have previously been employed, each with its special difficulty. The author puts this integral into the form—

$$C\sin\phi\int r^{-2}\sin\delta\,dt + C\cos\phi\int r^{-2}\cos\delta\cos\tau\,dt = W_e\sin\phi + W_p\cos\phi,$$

taking W_e and W_p to be the radiation received per unit area at the equator and pole respectively, and then proceeds to the estimation of W_e and W_p, which entails rather complicated mathematical work. [But he does not seem to have sufficiently allowed for the fact that W_e and W_p, as defined, are not constant but functions of ϕ, being not the total heats received at the equator and pole, but the heats received there during the day hours in latitude ϕ, where the length of a day is $\frac{2}{15}\cos^{-1}(-\tan\delta\tan\phi)$ hours.]

R. E. B.

666. *Rainfall of China and Korea.* **T. Okada.** (Monthly Weather Rev. 33. pp. 477–480, Nov., 1905. From Journ. of the Meteorological Soc. of Japan, vol. 24, No. 9, Sept., 1905.)—Supan's monograph on the rainfall of China, published in Petermann's Geograph. Mittheilungen, is so far the best work. The author analyses the rainfall tables for the period 1892 to 1901, taking most of his statistics from the Bulletins de l'Observatoire de Zikawei. His statistics concern 37 stations in China and 3 in Korea, most of which are situated on the coast or on islands. The inland stations are Peking; Wuhu, Hankau, Kiukang, Ichang, Chunking (these five up the Yangtsekiang); Wuchow and Longchow in Southern China. Northern China is drier than Southern China, and receives most of its rain in July and August, February being the driest month; in the south June is the wettest, and December the driest month. In Korea the west coast receives more rain than the east coast, and heavy rains are rare. [See also Abstract No. 1181 (1905).] H. B.

667. *Frequency Curves of Barometric Heights.* **J. P. van der Stok.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 548–561, Jan. 10, 1906. Proc. 8. pp. 549–563, Jan. 25, 1906.)—For this discussion the author has chosen the records of barometric heights, corrected for temperature, observed at Helder three times daily during the period Aug., 1843–July, 1904. The total number of observations is 67,252. In registering the numbers the decimals have been omitted, and then the frequency numbers are multiplied with a factor to bring up the total for each month to the same value. Then the average height was computed, and by means of simple linear interpolation the whole curve shifted in such a manner that the new frequencies correspond with deviations from the average value expressed in multiples of whole numbers. These summations are given in tabular form. From an analytical examination of the residuals calculations are made of the average duration of barometric disturbances, which for Helder are in winter = 6·90 days; summer = 4·89 days; spring or autumn = 6·04 days. C. P. B.

668. *Velocity of Propagation of Seismic Disturbance.* **V. Monti.** (Accad. Lincei, Atti, 15. pp. 15–18, Jan. 7, 1906.)—It is pointed out that the determination of the velocity of propagation of a seismic disturbance from the instants of recording the maximum disturbances on the seismograms at two stations is subject to considerable error. The motion of the pendulum which traces the horizontal seismogram is a forced vibration, and the author shows that it is the resultant of a number of harmonic motions, and that the maximum displacement occurs at a time depending upon the amount of damping of the ground at the place occupied by the observatory. Thus the phase of the maximum disturbance will be different at the two observatories if the damping of the seismic disturbance is different owing to the difference in geological formation at the two places. According to the author, it is necessary to register at each station the disturbances along three axes at right angles to each other, and also the rotations about these axes, before any deductions as to velocity of propagation can be made from the relative times of recording the disturbances. [See also Abstract No. 479 (1906).] S. G. S.

669. *Illustration of Seismic Wave-conductivity.* **S. Kusakabe.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 29. pp. 447–454, 1906.)—The author gives two sketches of earthquake action. In the one case the seismic centre was in the Pacific, and the greatest damage occurred, not on the palæozoic rocks near that shore, but far away in the quaternary near the Japan Sea. In the second case, districts situated on cainozoic rocks and on granite suffered most, while the intervening archæan rocks escaped. Reference is made to the paper abstracted in No. 2145 (1905), but there is hardly any geological detail. In the main portion of the paper the author points out that it is by no means accidental that most of the chief cities of Japan are situated in regions much exposed to earthquakes. The mountain valley with its limited area of cultivable soil of high fertility, intersected by a network of confluent streams, is the most unstable region. The centres of non-local strong earthquakes in Southern Japan further suffer most from *tsunami*, or destructive sea-waves from the Pacific. These conclusions need not apply to other countries, however. H. B.

670. *Relation between the Imperfect Elasticity of Rocks and Earthquake Motion.* **F. Omori.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 29. pp. 460–462, 1906.)—While appreciating the value of the researches of Nagaoka, Kusakabe, and Otani, the author cautions one against applying the results of their experiments on the elastic and other properties of rocks to the explanation of earthquake phenomena. Kusakabe argues that earthquake vibrations of small amplitude should travel faster than those of larger amplitude. But the velocity of the third phase of the prominent portion of earthquake motion is always 3·3 km./sec., be the earthquake small or large, the vibrations sharp or slow and insensible. According to Nagaoka's views on secondary vibrations [see Abstract No. 483 (1906)], the periods of earthquake vibrations should always become longer with increased amplitude; but this the author shows, by examples, does not hold either, the periods remaining practically constant during the principal and the end portions. Moreover, the displacements would be very small and within the elastic limit of rocks. **H. Nagaoka.** (Ibid. pp. 463–464, 1906.)—Nagaoka replies to Omori. Statical and kinetic experiments must be distinguished. The quantity, displacement/wave-length, referred to by Omori is arbitrary in vibrating systems, and the objection meaningless. By tapping prisms of sandstone periodically, Kusakabe had obtained summation frequencies $(n + hp)$ up to the 8th order, and difference frequencies $(n - hp)$ up to the 7th order. H. B.

671. *Horizontal Pendulum Observations of Earthquakes at Taichu, Formosa.* **F. Omori.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 29. pp. 458–459, 1906.)—The note is based on an examination of east–west diagrams of 12 earthquakes observed with a horizontal pendulum, natural period 15 sec., in 1903 and 1904. The most frequent periods of the preliminary tremor, the principal portion, and the end portion were 4·6, 4·97, 7·95 sec., identical with the P_1 period of the Tokyo seismograms. The principal pulsatory period Q_1 observed at Taito, on the eastern coast of Formosa, is 5·0 sec., and the most frequent pulsatory period of Tokyo is 4·4 sec. These P_1 and Q_1 periods, and likewise the P_2 and Q_2 periods of 8 sec., appear to occur in the records of earthquakes of some magnitude all over the world. H. B.

672. *The Kangra Earthquake of April* 4, 1905. (Nature, 73. pp. 418–419, March 1, 1906.)—Note on the preliminary account, contributed by C. S. Middlemiss to the Records of the Geological Survey of India, vol. 23. The Kangra earthquake was felt over an area of 1,625,000 sq. miles, the earthquake of 1897 over an area of 1,750,000 sq. miles. There were two centres of great violence, at Kangra and Dharmsala, and at Dehra Dun, each situated in an embayment of the great boundary fault of the Himalayas. Two or three distinct shocks were observed, while there was only one maximum of violence in 1897. Judging by the large motion records on the Milne seismographs, the rate of propagation between the origin and Bombay, Calcutta, and Kodaikanal was 1·95 to 1·98 miles/sec. H. B.

673. *The Tidal Waves caused by the Krakatoa Eruption of* 1883. **F. Omori.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 29. pp. 455–457, 1906.)—Referring to his observations on sea-level variations [see Abstract No. 1548 (1905)], the author points out that the periods of oscillations at a given place are the same, whether the tidal disturbances be caused by submarine earthquakes or by cyclones, and are identical again with those occurring in ordinary times. At Aden, Madras, and Karachi tide diagrams, showing oscillation periods of great length, 67 and 81 min., were observed not only after the Krakatoa eruption, but also in summer, 1904. The Krakatoa wave may have had four causes: (*a*) the fall of an enormous mass of the island into the sea; (*b*) seismic vibrations accompanying the eruption; (*c*) some upheaval or depression of the sea bottom; (*d*) the sudden expansion and compression of the air around the island at the moment of the eruption. Of these four, (*d*) was probably the principal cause both of the barometric fluctuations observed all over the world and of the tidal waves. H. B.

674. *Cause of Changes of Level in the Earth's Crust.* **O. Fisher.** (Amer. Journ. Sci. 21. pp. 216–220, March, 1906.)—The great changes in the relative levels of land and ocean which, according to Spencer and Hull, and also Nansen, have occurred even in Pleocene and early Pleistocene times, cannot, the author points out, be explained unless we assume a liquid substratum under the cooled crust. Convection currents would arise in the substratum, and the crust be elevated above an ascending column, and be depressed above a descending column. Descending columns would now be in progress beneath the large continental lowlands, and ascending currents beneath the oceans. Those changes would be cyclical [see Abstract No. 1550 (1905)]. Referring to Burrard's communication on the direction and force of gravity in India and the probable errors of Basevi's determinations [see Abstract No. 24 (1906)], the author suggests that there may have been a real change of density beneath Dehra Dun. H. B.

675. *Figure of the Sun.* **C. L. Poor.** (Astrophys. Journ. 22. pp. 305-317, Dec., 1905.)—Additional observations apparently confirming the variation of the figure of the sun [see Abstract No. 27 (1906)] have been recently published by Ambronn embodying heliometer measures made with the Göttingen heliometer during 1890–1902. Schur determined a series of measures of the solar diam. throughout the whole of a sun-spot cycle of 11 years or thereabouts, and, to obviate errors as far as possible, two complete and independent series of observations were made by himself and Ambronn. In their discussion Ambronn found the mean solar diam. for the whole series; then the residual for each observation by subtracting the mean. From these residuals he obtained the mean residual for each year, and thus the yearly variation in diam. The table of these variations shows a periodicity with a time of between 6 and 8 years. The author considers this method

could not lead to the detection of any changes in the diameters, and rediscusses the whole series of values. He then detects a decided periodicity, the polar diam. being larger in 1890–91, while the equatorial diam. was greatest during 1892, 1893, and 1894. The exact length of the period is uncertain, but it appears to be nearly the same as the sun-spot period. The amplitude of the variation is 0″·2; the difference between the largest positive and negative values being about 0″·5. These heliometer measures thus corroborate the conclusions previously determined from Rutherford's photographs, but the amplitude of the variation is much less in the case of the visual observations. C. P. B.

676. *Photographic Determination of Moon's Position.* **E. B. H. Wade.** (Royal Astron. Soc., Monthly Notices, 66. No. 2. pp. 46–49, Dec., 1905. Nature, 73. p. 352, Feb. 8, 1906. Abstract.)—From preliminary experiments at the Helwan Observatory, Egypt, the author has obtained promising results in the endeavour to record the moon's position among the stars. A photographic camera is mounted so that its optical axis passes horizontally through the centre of an ordinary cœlostat, but the mirror of the latter, instead of being worked to a true plane, is figured as a prism, the two faces of which are inclined at an angle of 72°, and the edge of the prism is arranged parallel to the polar axis. The camera will then receive light from two regions of the sky situated 15° apart in right ascension. The cœlostat is then adjusted to reflect the moon from one face of the prism and stars from the other into the camera. The stars are exposed for 2½ min., the moon being intercepted meanwhile, then the moon is exposed for a fraction of a second and again intercepted, while a further exposure of 2½ min. duration is given to the star field. By this method the author has obtained a number of successful results, using a 4-in. cœlostat prism mirror, in conjunction with a 2-in. Dallmeyer telescope lens. C. P. B.

677. *Motion of the Calcium Vapour in the Sun.* **W. S. Adams.** (Astrophys. Journ. 23. pp. 45–53, Jan., 1906. Contributions from the Solar Observatory, No. 6.)—Special studies of the H and K lines of calcium have been made in order to determine the conditions of their occurrence in prominences and over the spot areas on the solar surface. The observations have been made with the large Littrow spectroscope of the Solar Observatory at Mount Wilson, Pasadena, consisting of a 3½-in. plane grating used in connection with a 4-in. lens of 62 ft. focal length, fed with light from a cœlostat, and giving a solar image 7 in. diam. Numerous measures were made to determine the exact wave-length of the fine central bright line, while the slit was adjusted along various known regions of the disc. Those taken over spots show some slight indications of a *longer* wave-length than on the general surface. From the final measures, compared with the artificial standards of aluminium and iron, it is concluded that the relative solar wave-length as given by Rowland, of H as referred to K, is in error by about 0·010 unit. It is evident that no definite wave-length can be ascribed to these lines in the solar spectrum, since the vapour giving rise to them has different motions on different parts of the sun's surface. C. P. B.

678. *Photographic Photometry of Short-period Variables.* **J. A. Parkhurst** and **F. C. Jordan.** (Astrophys. Journ. 23. pp. 79–91, Jan., 1906.)—During the autumn of 1905 attempts were made to determine photographically the light-curves of several stars known or suspected to be variables of very short

period. The instrument employed was the 24-in. reflector of the Yerkes Observatory, and the records were obtained by exposing to the star for several intermittent times on the same plate. The diameters of the star images were then measured in both co-ordinates, and the corresponding magnitudes computed by Charlier's formula. This method is considered superior by reason of (1) the excellent definition of the reflector images; (2) star images were measured directly under the microscope to 0·001 mm., instead of being compared with a scale plate; (3) great speed of photographic action of the reflector makes it possible to follow faint stars down to minimum, with practicable exposure time. Tabular results are given of the variations found in the stars—U Cephei, W Ursæ Majoris, 14 (1904) Cygni, and 32 Cassiopeiæ.

C. P. B.

679. *Sun-spot Periodicities.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 77. pp. 141–145, Feb. 8, 1906.)—The diagram is computed representing the intensity of periodic variations as determined from the sum of the squares of the two Fourier coefficients belonging to each assumed period. This will then represent for any regular or irregular change exactly what the energy diagram gives us for a luminous disturbance, which is analysed by a spectroscope. As far as data are available, this has been done for sun-spot variability. For periodic times which exceed 4 or 5 solar rotations (100–125 days) the author has used the mean daily areas in each synodic rotation of the sun as published by the Solar Physics Committee, reaching back as far as 1832. For shorter periods than these the Greenwich measures have been employed for each day since 1883. For periods longer than 3 years Wolf and Wolfer's sun-spot numbers have been used, being available from 1749. The periodogram of 150 years showed the expected masked peak corresponding to the 11-year period, but the two separate diagrams for 1750–1825, and 1825–1900, appeared at first to have nothing in common. The first showed two periodicities of 13¾ and 9¼ years respectively, while the second only indicated a period of 11·12 years. For investigation the rotation period of Jupiter and the synodic periods of revolution of Venus and Mercury were examined, but reveal no trace of planetary influences. The most persistent period found is 4·81 years, and has an amplitude about ⅛ that of the 11·12-year periodicity. There is strong evidence of a cycle of 8·38 years' duration. A very suggestive connection is noticed between the three periods thus derived, viz., 4·81, 8·38, and 11·125. It will be seen that if frequencies are considered instead of periodic times the sum of the frequencies of the two latter periods agree with the frequency of the first. C. P. B.

REFERENCES.

680. *Theory of Friction.* **G. A. Maggi.** (N. Cimento, 10. pp. 240–254, Oct., 1905.)—The theory of friction due to Painlevé and developed by E. Daniele [see Abstracts Nos. 1880 (1904) and 1673 (1905)] is compared with the ordinary theory, both in the postulates and in the method of attacking particular problems, the advantages of the new method being pointed out. S. G. S.

681. *Lateral Vibration of Bars.* **J. Morrow.** (Phil. Mag. 11. pp. 354–374, March, 1906. Communicated by the Physical Society.)—The analysis given here is on the same lines as in the previous paper [Abstract No. 1711 (1905)]. Unloaded bars, loaded bars of negligible mass, and loaded massive bars are dealt with.

J. W. P.

682. *Glass Manometer on the Principle of the Bourdon Gauge.* **E. Ladenburg** and **E. Lehmann.** (Deutsch. Phys. Gesell., Verh. 8. 3. pp. 20–22, Feb. 15, 1906. Phys. Inst. d. techn. Hochschule, Charlottenburg, Jan., 1906.)—Having occasion to measure the pressure of ozonised oxygen, the authors use a glass manometer consisting of a flat glass tube bent to a half-circle. One end of this tube is connected to the main apparatus, while the other end is drawn out to a fine point. The excursions of this point are observed by means of a microscope. E. C. C. B.

683. *Harmonic Analysis.* **J. Harrison.** (Engineering, 81. pp. 201–202 and 204, Feb. 16, 1906.)—By Fourier's theorem a single valued function can always be represented by the sum of a series of sines and cosines. The author's method of analysing a given curve is based on that of C. Runge (see *Introduction to the Calculus*, by G. Gibson, Chap. XI.), but it is carried out graphically. The motions of machines when analysed are generally found to be represented by series which converge very rapidly. The first three terms in these cases can be easily found by taking eight ordinates and using the graphical method of calculation. A. R.

684. *Deformation of an Elastic Ellipsoid.* **T. Boggio.** (Accad. Lincei, Atti, 15. pp. 104–111, Jan. 21, 1906.)—The equation for the deformation of an ellipsoid subjected to tensions acting on its boundary is obtained in terms of a number of variables. When these reduce to two the equation can be employed to determine the deformation of a thin sheet of isotropic material subjected to tensions at its boundary. [See also Abstracts Nos. 329 and 1179 (1905).] S. G. S.

685. *Vibrations of an Elastic Body with its Surface at Rest.* **A. Korn.** (Comptes Rendus, 142. pp. 508–510, Feb. 26, 1906.)—It is shown that there is an infinite number of triplets of functions which with their first differential coefficients are continuous throughout a given volume and vanish at its surface, each triplet satisfying within the volume the equations of displacement of a particle on the elastic theory of solids. R. E. B.

686. *Theory of the Solitary Wave in a Horizontal Elastic Tube.* **A. Boulanger.** (Comptes Rendus, 142. pp. 388–391, Feb. 12, 1906.)—In continuation of a former paper [see Abstract No. 241 (1906)] the rate of decay of velocity of a solitary wave is investigated. [But there is some mistake in the work, since a particular coefficient of friction occurs in different places with the different dimensions $M^{\frac{1}{2}}L^{-1}$, $M^{\frac{1}{2}}L^{-1}T^{-\frac{1}{2}}$, $ML^{-2}T^{-1}$.] R. E. B.

687. *Lemmas relating to Quasi-waves of Shock.* **P. Duhem.** (Comptes Rendus, 142. pp. 377–380, Feb. 12, 1906.)—Expressions are found for the relation between the rates of change in position and in time of any magnitude that varies very abruptly across a quasi-wave, terms of the first order of small quantities alone being taken into account. (Ibid. pp. 491–493, Feb. 26.) A mathematical inequality which does not lend itself easily to physical interpretation. R. E. B.

688. *The Oceanic Circulation.* **Thoulet** and **Chevallier.** (Comptes Rendus, 142. pp. 245–246, Jan. 22, 1906.)—The authors suppose determinations of the temperature and chemical composition, and more particularly of the density of the sea-water, to be made in three verticals at three spots, as previously indicated [see Abstract No. 997 (1904)]. It would follow from the density relations in the triangular prism of water that the general movement of the water should be obliquely upward. That is to say, that, while continental rivers follow a downward slope, ocean currents should stream upward. If two ocean currents meet, the heavier water dives under the lighter. The rapid evaporation of the surface water in the tropics is regarded as the probable cause of this circulation. Reference is made to the Gulf Stream, but not to the rotation of the earth. H. B.

689. *Motion of a Wire through a Lump of Ice.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 629–635, Feb. 7, 1906. Proc. 8. pp. 653–659, Feb. 21, 1906.)—An approximate theory of the motion of a wire with weighted ends through a block of ice on which it is placed is here worked out. The agreement of the theory with the results of Meerburg's experiments, which have not yet been published, is not very satisfactory. R. E. B.

690. *Radius of Molecular Attraction.* **C. W. Chamberlain.** (Phys. Rev. 21. pp. 63–64, July, 1905. Abstract of paper read before the Amer. Phys. Soc., April 22, 1905.)—Quincke found 5×10^{-6} cm. for this quantity, whereas Johonnott found 6×10^{-7} cm. for the minimum thickness of a soap film [see Abstracts Nos. 1338 (1899) and 2040 (1905)]. Measurement of a silver wedge formed on optical glass and tested by a multiple reflection interferometer shows that Quincke's value is at least twice too large. G. E. A.

691. *Trombe of very small Dimensions at Perrache.* **M. Luizet.** (Comptes Rendus, 142. pp. 470–471, Feb. 19, 1906.)—According to the report of Craponne, engineer to the gasworks at Perrache, on the Saône, the whirlwind came suddenly in the afternoon of Jan. 6, ten minutes after a slight fall of hail, and in five or six seconds did a good deal of damage, confined to a belt of 40 m. width and 150 m. length. A barometer, 20 m. off the track, did not mark any disturbance, while at the observatory Saint-Genis-Laval, 6 km. distant, a sudden wind and a rise of the barometer were recorded. H. B.

692. *Variation of Latitude* **H. Kimura.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 24. pp. 357–364, 1905.)—The author reviews the history of our knowledge of latitude variation, with various descriptions of the methods of reduction employed. C. P. B.

693. *Observations of Comet Schaer* (1905*d*) *at Rome.* **E. Millosevich.** (Accad. Lincei, Atti, 14. p. 569, Dec. 3, 1905.)—This comet, discovered by E. Schaer on Nov. 17, 1905, at Geneva, Mass., was originally of about the 7th magnitude, but its brightness has decreased. An approximate ephemeris is given. L. H. W.

694. *Observations of Phœbe.* **H. Struve.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 51. pp. 1058–1061, Dec. 14, 1905.)—A summary of observations on the satellite, made by various astronomers, with explanatory remarks. C. P. B.

695. *Curvature of the Solar Trajectory.* **E. Belot.** (Comptes Rendus, 142. pp. 72–74, Jan. 8, 1906.)—From a discussion of the longitudes of perihelion of certain well-determined comets, a series of values for the apex and anti-apex of the sun's way are deduced, and it is concluded that the centre of curvature of the solar trajectory has been formerly in the plane of the ecliptic near to longitude 180°. C. P. B.

696. *Comet Lowell* (1905*e*). (Nature, 73. p. 232, Jan. 4, 1906.)—Announced by telegram from Kiel, as discovered at the Flagstaff Observatory on Nov. 29, 1905, in the Constellation Aquarius, about half-way between ϕ Aquarii and i Ceti. C. P. B.

697. *An Observation of the Zodiacal Light to the North of the Sun.* **S. Newcomb.** (Astrophys. Journ. 22. pp. 209–212, Oct., 1905.)—The author suggests, as a result of his observations on the Brienzer Rothorn, that the zodiacal light be hereafter described, not as "lens-shaped," but as a luminosity surrounding the sun on all sides, of which the boundary is nowhere less than 35° from the sun, and which is greatly elongated in the direction of the ecliptic. L. H. W.

LIGHT.

698. *Five-foot Spectroheliograph of Mount Wilson Solar Observatory.* **G. E. Hale** and **F. Ellerman.** (Astrophys. Journ. 23. pp. 54–63, Jan., 1906.)—Detailed description is given of the construction and arrangement of the new spectroheliograph for use with the Snow telescope [see Abstract No. 490 (1906)] at the Solar Observatory on Mount Wilson, California. Numerous improvements have been made on the Rumford instrument at the Yerkes Observatory, the chief of which are (1) larger aperture of collimating and camera objectives (8 in.) obviating loss of light at the sun's limb; (2) possibility of photographing the entire disc with high dispersion; (3) ease of attaching slits of different curvature for work with various lines; (4) provision for using from one to four prisms, and one or two mirrors in the optical train; (5) wide range of speed of the driving mechanism; (6) elimination of distortion and ease of manipulation. The first results are interesting as giving details of the solar surface photographed through the lines $H\delta$ and $\lambda 4045$ for showing the hydrogen and iron flocculi respectively. Three of these photographs are reproduced in the paper, from which it is seen that the iron flocculi agree very closely in form with the low-level calcium forms. Most of the hydrogen flocculi are shown dark, as was found during previous work, and a special feature is the presence of narrow, bright rings, partially or completely encircling certain sun-spots, which are distinctly lighter than the general background. These are to be distinguished from the bright eruptive phenomena which are frequently shown on hydrogen photographs. The bright eruptions change rapidly in form, whereas these bright rings, which are usually much less brilliant than the eruptions, do not change materially in the course of several hours. They may possibly be taken to indicate the existence of comparatively hot regions in the chromosphere closely encircling certain spots. C. P. B.

699. *Diffraction of Short Waves by a Sphere.* **J. W. Nicholson.** (Phil. Mag. 11. pp. 193–205, Feb., 1906.)—The effect of a rigid sphere upon incident plane sound-waves has been examined by Rayleigh, who has obtained a complete solution of the case, in which the waves have a length great in comparison with the dimensions of the sphere. In the more general case, Rayleigh has expressed the disturbed motion in the form of an infinite series, whose terms consist of products of surface zonal harmonics and functions derived from Bessel functions. The summation of the series cannot be effected, but when the waves are very long it was shown to reduce practically to its first two terms. In the present paper a close approximation is obtained for the case of diffracted waves very short in comparison with the radius of the spherical obstacle. Rayleigh's method is used until the introduction of approximations, and the final result appears in the form of a definite integral which may be evaluated to the same order of approximation. The analysis is not suitable for abstraction. E. H. B.

700. *Measurement of the Change of Phase at Reflection.* **A. Perot.** (Comptes Rendus, 142. pp. 566–568, March 5, 1906.)—Between a source of light such as the iron arc and a powerful spectroscope, a wedge-shaped inter-

ference layer is inserted whose image is focussed upon the slit. Each point of the slit is thus illuminated by rays which have traversed a definite thickness of the interference layer. The spectrum lines are thus broken in a series of interference fringes which are generally inclined to the direction of the spectrum owing to the dispersion introduced by the change of phase at reflection within the silvered interference layer. A straight line is drawn normal to the spectrum lines, and let λ and λ_0 be the wave-lengths corresponding to the intersection of this line with two of the fringes. We have then $2e - 2\epsilon_0 = k\lambda_0$ and $2e - 2\epsilon = (k + 1)\lambda$, where e is the geometrical thickness of the layer and ϵ the difference between this thickness and the distance between the reflecting planes, and k is a whole number. From this we have $2(\epsilon - \epsilon_0) = \lambda - k(\lambda_0 - \lambda)$, and $2(\epsilon - \epsilon_0)$ is the remainder from the division of λ by $\lambda_0 - \lambda$. E. C. C. B.

701. *Metallic Reflection and the Layer of Transition.* **R. C. Maclaurin.** (Roy. Soc., Proc. Ser. A. 77. pp. 211–234, March 6, 1906.)—It is well known that where light is propagated in an absorbing medium, the dynamical equations and the boundary conditions are of exactly the same form as for a transparent medium. From a mathematical point of view the only difference between the two cases is that μ, the refractive index in a transparent medium, is replaced in the absorbing medium by a complex quantity $\mu - ia$, where μ is the "refractive index" of the medium, *i.e.*, the ratio of the velocity of light in air to that of the medium, and a is the coefficient of absorption. The paper then develops the mathematical theory of the problem, and compares the results with the experiments of J. Conroy, Quincke, and Drude. The chief results of the investigation may be summarised as follows:—(1) In metallic reflection, if the transition from one medium to the other be abrupt, the Principal Incidence is always near the quasi-polarising angle, and is given very approximately by the formula—

$$\mathrm{Sec}\ \phi = \mathrm{M} + \mathrm{M}^{-1}(1 - \tfrac{1}{2}\cos 2a),$$

where $\mathrm{M}\,e^{-ia} = \mu - ia$. (2) Even when great care is taken to clean the surface of a metal, the transition from it to the neighbouring medium is often gradual, and not abrupt. This is in acccordance with experimental and theoretical investigations on reflection from transparent substances, such as glass and diamond. (3) The influence of this layer on the ellipticity of the reflected light, and on the difference of phase between light polarised perpendicularly and parallel to the plane of incidence extends over a wider range than in the case of transparent substances. (4) The thickness of the layer is of about the same order of magnitude as with transparent media. (5) The layer affects the position of the Principal Incidence considerably, and also influences the Principal Azimuth. (6) Hence the deduction of the optical constants of a metal from observation of the Principal Incidence and Azimuth alone is liable to considerable error. In the case of steel this method leads to $\mu = 2{\cdot}249$ and $a = 3{\cdot}257$, while the wider theory yields $\mu = 2{\cdot}134$ and $a = 2{\cdot}906$. (7) Four constants are required to describe the optical properties of a metallic reflector, two of them depending on the nature of the layer of transition. (8) With these four constants a very satisfactory agreement exists between theory and experiment, as regards both the intensity of the reflected light and the difference of phase between the lights polarised perpendicularly and parallel to the plane of incidence. [See also Abstracts Nos. 1230 (1905) and 81 (1906).] E. H. B.

702. *Best Rays to Unite at a Common Focus in Designing an Achromatic Objective.* **J. Wilsing.** (Zeitschr. Instrumentenk. 26. pp. 41–48, Feb., 1906.) —The discussion is limited to a system of two lenses (whose thicknesses are neglected), which enables rays of two different wave-lengths to be brought to a common focus at a given point on the axis. The residual chromatic aberration, or secondary spectrum, depends on the two rays selected, as well as on the properties of the glasses. The method adopted for finding the best rays to select, is to select them and then find what happens, as follows: A definite limited region only of the spectrum is considered, differing accordingly as the objective is for visual or photographic use. Within this region the secondary spectrum is to be as small as possible—a condition the author expresses by assuming that the sum of the squares of the focal deviations from a mean value is to be a minimum, or $\Sigma_{\lambda_1}^{\lambda''} dF^2$ minimum (λ', λ'' denoting the wave-lengths of the two extremes of the region considered, λ° the wave-length corresponding to the given focus, and the subscripts 1 and 2 refering to the two glasses). To connect index and wave-length, the Hartmann-Cornu dispersion formula $n = a + [c \div (\lambda - l)]$ is adopted, a c l being constants. From these, and the usual relations, general expressions [too lengthy for quotation] are obtained, connecting A and B, the curvature sums of the lenses, with λ' λ'' λ° and constants depending on the glasses. By substituting any desired values of λ' λ° λ'' in these expressions, the corresponding values of A and B are deduced. Then by means of the formula—

$$1/F = (n_1 - 1)A + (n_2 - 1)B$$

the foci for a series of other wave-lengths are obtained, and by plotting the values of $F - F_0$ (F_0 being the given focal length corresponding to λ_0), the course of focal deviation can be exhibited graphically. Examples are given, and the effect of varying the focus is also discussed. The author appears to disagree with the Jena authorities respecting their claim that by means of their new glasses three rays can be united, or in other words a tertiary residual spectrum obtained, with two lenses. On p. 45 he remarks that Hovestadt's deduction of a tertiary spectrum for the glasses "S. 8" and "S. 30" is erroneous, and due to the roughness of the figures used in calculation. Hovestadt's focal curve has a point of inflection, while the author's is parabolic, but nearly approaching a straight line, in the region considered. [See Everett's translation of Hovestadt's "Jena Glass," pp. 33–34. The question appears to be one of decimal places lying beyond the limits of possible error in the data.] A. E.

703. *Resolving Power of Spectroscopes.* **H. Morris-Airey.** (Phil. Mag. 11. pp. 414–416, March, 1906.)—Schuster's condition for the resolution of the corresponding lines of two homogeneous radiations by a grating spectroscope appears to contain no factor depending on the position of the grating or prism. It is shown, however, that the purity of the spectrum becomes greater as the angle of incidence of the light on the grating increases, and that this result is really included in Schuster's formula. The width only of the effective portion of the slit should be considered in determining the factor ψ (angle subtended by collimator-lens at slit), and ultimately, by reducing ψ, the full resolving power is reached with great width of slit, it being possible to separate the sodium D-lines with a grating of 1,300 to 1,400 lines when the slit is 0·5 cm. wide. In most cases the collimator can be entirely omitted. G. E. A.

704. *Line Structure.* **P. G. Nutting.** (Astrophys. Journ. 23. pp. 64–78, Jan., 1906.)—In choosing spectrum lines for standards of length or for interference measurements, it is important that they should possess the simplest possible structure. A very extensive series of measures has been made by the author at the Washington Bureau of Standards, with the Echelon grating, using varied sources of light, Plücker tubes, electric spark and arc under different strengths. The main characteristics of the lines of the chief metals are described in detail. It is found that the structure of most lines is very variable, the components and satellites constantly altering in number, relative intensity and position with every slight fluctuation of the sources. With these restrictions the structures found are classed in five groups. (*a*) Lines accompanied by faint companions or satellites of the nature of distinct spectrum lines, such as the yellow helium and green mercury lines. (*b*) Lines that, while originally single and simple, merely broaden indefinitely with increasing intensity. The lines of gold belong to this class. (*c*) Lines that in the intermediate stage turn with sharp, widely-separated components. The lines of iron and platinum exhibit this. (*d*) Lines that are triple in the intermediate stage, the single lines first developing wings. (*e*) Miscellaneous action, comprising a few lines which broaden, double, or triple unsymmetrically. The green thallium line is characteristic of this class. All the lines in those spectra—Fe, U, Ba, for example—for which no series relations are known, are alike in structure and behaviour, the observed structure at any time being a function of the intensity alone. Where series relations are known, lines of the same spectral series behave alike, but often quite differently from lines in another series. Lines occurring in pairs with constant frequency-difference are alike in structure and behaviour in each pair, and usually in all the pairs of the spectrum. It is thus considered that for standardisation purposes the lines must be selected entirely from class (*b*), which gives an abundance of arc lines of sufficient intensity. [See also Abstract No. 1384 (1905).]

C. P. B.

705. *Resolution of the Spectrum Lines of Mercury, Cadmium, Sodium, Zinc, Thallium, and Hydrogen.* **L. Janicki.** (Ann. d. Physik, 19. 1. pp. 36–79, Jan. 18, 1906. Extract from Inaug. Dissertation, Halle, 1905.)—A lengthy investigation into the complexity of the lines of the above spectra by means of a large echelon grating. The results are given in great detail, and it is to be noticed at once that the number of components observed is not so great as hitherto supposed, owing no doubt to the fact that Lummer and Gehrcke observed and measured a number of ghosts. The author did not observe any changes in the wave-lengths of the satellites, but only considerable changes in their relative intensities. E. C. C. B.

706. *Flame-spectrum of Mercury.* **C. de Watteville.** (Comptes Rendus, 142. pp. 269–270, Jan. 29, 1906.)—By employing Gouy's apparatus and a solution of the acetate or cyanide of mercury the author has succeeded in observing in the flame-spectrum one line, viz., $\lambda = 2537$. Even though an exposure of 10 hours was given, no other line could be observed. Comparing the results with the analogous elements Mg, Ca, Zn, Sr, Cd, and Ba, Ramage's curves show that the flame spectrum of mercury should contain the line $\lambda = 3650$. E. C. C. B.

707. *Spectrum of the Spontaneous Luminous Radiation of Radium.* **W. Huggins and Lady Huggins.** (Roy. Soc., Proc. Ser. A. 77. pp. 130–131, Feb. 8, 1906.)—It has been recently shown that the air immediately surrounding a sample of radium bromide is glowing and shows four of the bands of the nitrogen spectrum. The authors confirm this observation and extend it to include all the nitrogen bands. When the radium salt is enclosed in a thin glass tube the air immediately surrounding the tube is not rendered luminous, which shows that the luminosity is not due to the β-radiation which passes freely through glass. [See also Abstract No. 103 (1906).] E. C. C. B.

708. *Emission of Light by Canal Rays.* **J. Stark.** (Nature, 73. pp. 389–390, Feb. 22, 1906.)—This note summarises the results previously given [see Abstracts Nos. 297 and 521 (1906)], and gives the results of certain additional experiments. The total radiation from the canal rays is partially polarised, the amount of polarisation being slight, the maximum of electrical vibration being parallel to the direction of translation. The hydrogen lines are nearer the red than those emitted by the slowly moving ions of the negative glow, the displacement being apparently proportional to the square of the velocity, that of the middle of H_β being approximately 0·8 Ångström unit for a velocity of $1{\cdot}2 \times 10^8$ cm. per sec. There is also a broadening of the lines. S. G. S.

709. *Decay of Phosphorescence.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 21. pp. 411–413, Dec., 1905. Abstract of paper read before the Amer. Phys. Soc., Oct. 28, 1905.)—According to E. Wiedemann and Wiedemann and Schmidt, the light is emitted during the recombination of the products of the dissociation produced during excitation. It is shown that the modified theory of Wiedemann and Schmidt accounts for Stokes's law and also for the fact that the luminescence light is unpolarised even when excited by polarised light, and the single band spectrum is independent of the wave-length of the exciting light. The simple law of recombination of the products of dissociation ($du/dt = -an^2$) gives results which are found to hold good for the first 10 or 15 sec., but after that time the decay is found to be more gradual than that indicated by the law. S. G. S.

710. *Phosphorescence of Pyro-Soda Developer.* **T. A. Vaughton.** (Nature, 73. p. 389, Feb. 22, 1906.)—In a previous note the author has described the rendering phosphorescent of a photographic plate by placing it in a developer (pyro-metol-soda solution) and then in a solution of aluminium sulphate. [See Abstract No. 763 (1904).] Continuing his investigation, the author finds that an exposed plate when developed and placed in an aluminium sulphate solution becomes a phosphorescent negative, the unexposed parts being highly phosphorescent and the exposed parts not so. A thorough washing before immersion in the aluminium sulphate solution destroys the effect, showing that the presence of the developer is necessary. A mixture of the developer and the solution will phosphoresce, and the phosphorescence is much modified by the presence of the salts of various metals. Most of these diminish the effect, the only salt which increases it being gold chloride. S. G. S.

711. *Conductivity of Air due to Sulphate of Quinine.* **F. C. Gates.** (Phys. Rev. 22. pp. 45–46, Jan., 1906. Abstract of paper read before the Amer. Phys. Soc., Oct. 28, 1905.)—An attempt is made to decide whether the

conductivity is due to hydration or to ultra-violet light accompanying phosphorescence. Reduction of the pressure greatly increases the ionisation current so long as the quinine is first heated in the open air. If heated in the exhausted chamber, the conduction is absent; but, on allowing fresh air to enter, both ionisation and phosphorescence result. The presence of moisture is necessary for these effects, pointing to hydration as the explanation. It is concluded that either the ionisation is due to light accompanying the phosphorescence, or that each is caused by hydration. No ultra-violet light is found as the result of direct tests. [See also Abstract No. 289 (1904).] R. S. W.

712. *Polarisation in Secondary Röntgen Radiation.* **C. G. Barkla.** (Roy. Soc., Proc. Ser. A. 77. pp. 247-255, March 6, 1906.)—Preliminary experiments showed that it was possible, by using carbon as the radiator, to produce a secondary beam of Röntgen rays of great intensity and capable of setting up a tertiary giving quite an appreciable ionisation in air. A mass of carbon was then placed near an excited Röntgen-ray tube so as to be subject to a primary beam of considerable intensity. It was then the source of a secondary radiation, the total energy of which was quite a large fraction of the energy incident upon it. A beam of this secondary radiation proceeding in a direction perpendicular to that of propagation of the primary falling on the carbon was studied. In this secondary beam was placed a second mass of carbon, and the intensities of tertiary radiation proceeding in two directions at right angles and perpendicular to the direction of propagation of the secondary beam were observed by means of electroscopes placed in its path. The Röntgen-ray tube was turned round the axis of the secondary beam, while everything else was fixed, and the relative intensities of the tertiary radiations observed for different positions of the tube. It was found that the intensity of tertiary radiation reached a maximum when the directions of propagation of the primary and tertiary were parallel, and a minimum when they were at right angles, showing the secondary radiation proceeding from carbon in a direction perpendicular to that of propagation of the incident primary to be polarised. The amount of polarisation was very great in comparison with what had been found in the primary beam proceeding direct from a Röntgen-ray tube, and indicated almost complete polarisation of the secondary beam. J. J. S.

713. *Specific Action of Substances on Röntgen Rays and Secondary Rays.* **Hurmuzescu.** (Annal. Scientifiques de l'Univ. de Jassy, 3. pp. 258-287, Jan., 1906.)—The specific action of the metal in the electric discharge by the Röntgen rays and by the secondary rays, and also the part played by the metal in the transformation of the Röntgen rays into secondary rays, were studied by observing the rate of discharge of an electrometer produced by the rays under different circumstances. It was found that: (1) The activities of the Röntgen rays acting on certain different metals was as follows in decreasing order: Pb, Fe, Ag, Sn, Al. (2) The order of the activities of the secondary rays (S-rays) arising by the transformation of the Röntgen rays by different metals depends on the nature and thickness of these bodies. These activities for the metals employed are in the following decreasing order: (Co, Ni, Fe, Cu, Zn) (Pb, Cd, Bi, Ag) Sn (Al, Mg). They are separated into three principal groups. (3) This order does not appear to change when these rays are filtered through metallic sheets of different nature and thickness. The activities appear not to be in a simple relation with the molecular weights of the substances. The specific action of the metal comes into account both in the direct action of the Röntgen rays on the charged bodies and also in the case of the S-rays having their origin on these bodies. These two actions should have a close connection. The order of the activities of the different metals for the two phenomena may be expected to be the same, or a body should lose its charge the more quickly the more absorbent it is for the Röntgen rays. So a substance may be expected to produce S-rays the more active, for the same bundle of incident Röntgen rays, as the substance is more opaque to these rays. But according to Benoist's observations the absorption of the Röntgen rays is in the inverse ratio of the atomic weights of the bodies. If for the first phenomenon this law is followed to a certain extent, for the second the order of the metals is quite different, and this independently of the absorptions to which the S-rays are submitted on their path to the electrometer. For example, the secondary activity of iron is greater than that of lead. The following explanation is suggested: The Röntgen rays striking a body produce by their pulsations a state of vibration of its molecules. These motions can determine easily the splitting-up of the molecule into ions and electrons in the case of gases where the molecule is free, but with more difficulty in a liquid or solid. The greater the molecular weight the more complex is the molecule and the more easily the vibrations are able to set at liberty the electrons, consequently the more easily the body discharges itself. In this phenomenon it is also necessary to take account, perhaps, not only of the molecular weights but also of the numbers of molecules in a given section of the beam. By this hypothesis metallic bodies are supposed to vaporise or pulverise themselves under the influence of these radiations. The discharge by Röntgen rays and ultra-violet rays has been previously explained on this supposition. J. J. S.

714. *Radio-active Transformation.* **P. Gruner.** (Ann. d. Physik, 19. 1. pp. 169–181, Jan. 18, 1906.)—This is a discussion of the stages in the transformation of radium which have been theoretically dealt with by Rutherford, Soddy, Curie, and Danne. The author attempts to give a more complete theory than heretofore, and shows that the assumption that the transformation of radium B into radium C takes place without the expulsion of electrons is not admissible, since the third constant of transformation is nearly one-seventh of the fourth constant, and therefore cannot be neglected in comparison. E. E. F.

715. *Relation between Radio-activity and Composition of Uranium Compounds.* **H. N. McCoy.** (Phil. Mag. 11. pp. 176–186, Jan., 1906. Paper read before the Amer. Phys. Soc., April 21, 1905. Phys. Rev. 20. p. 381, June, 1905. Abstract.)—The fact that only a roughly approximate proportionality was found to exist between the radio-activity of pure uranium compounds and their content of uranium has been shown to be due to neglect of the absorption of the α-rays by the compounds themselves. The following method is given for preparing an empirical standard of radio-activity, which can be reproduced with an accuracy of a few tenths of 1 per cent. Ordinary uranium salts are purified by successive treatments with ammonium carbonate, ammonium sulphide, and barium salts. The precipitated ammonium uranate is converted into the oxide, U_3O_8, by ignition in a stream of oxygen. 0·8–1·0 gm. of the oxide is ground to an impalpable powder in an agate mortar with a little freshly distilled chloroform. The powder is then stirred up with about 15 c.cm. more of chloroform and is poured into a shallow metal dish about 7 cm. diam., which is kept covered until the solid has settled, the chloroform being afterwards allowed to evaporate spontaneously. The oxide is left as a uniform black film adhering to the dish and may be used daily for months without deterioration. The total activity of 1 gm. of uranium is 791 times the observed or surface activity of each sq. cm. of such a film. For five different minerals containing varying proportions of uranium, the ratio of activity to uranium content is found to have a very nearly constant value, namely, 3,280, which is 4·15 times the corresponding value for pure uranium compounds. These results tend to confirm the conclusion that uranium is the parent, not only of radium, but also of all the other active substances accompanying it. Radium is about $4{\cdot}25 \times 10^6$ times more active than uranium. [See also Abstract No. 1222 (1905).] T. H. P.

716. *Magnetic and Electric Deflection of the α-Rays from Radium.* **E. Rutherford.** (Phys. Rev. 22. pp. 122–123, Feb., 1906. Paper communicated to the Amer. Phys. Soc., Dec. 29, 1905.)—The paper is a preliminary account of experiments made to determine with accuracy the ratio e/m of the α-particles from radium C. The values of e/m lie between $5{\cdot}0 \times 10^3$ and $5{\cdot}2 \times 10^3$. The initial velocity of the rays is 2×10^9 cm./sec. Since e/m for the hydrogen atom is about 10^4, it appears that the apparent mass of the α-particle is twice that of the hydrogen atom; but whether it is a molecule of hydrogen, an atom of helium, or a helium molecule carrying twice the ionic charge is undecided. [See also Abstract No. 1589 (1905).] R. S. W.

717. *Spontaneous Ionisation of Air.* **H. Geitel.** (Deutsch. Phys. Gesell., Verh. 8. 3. pp. 23–38, Feb. 15, 1906.)—The author discusses the theories advanced to account for the spontaneous ionisation of air contained in closed vessels. Traces of emanation are often present, especially in subterranean vaults, but in the absence of these, ionisation is often accounted for by the action of the glass walls of the tube, since it is known that even at ordinary temperatures many varieties of clay and other silicates emit large numbers of ions. Apart from these two causes of ionisation, there is the penetrating radiation which Madame Curie suspected to be disseminated throughout the universe. The author succeeded in partially screening an electroscope from this radiation by taking it to the bottom of the Hedwigsburg salt mine. Many pure minerals like quartz, calcium carbonate, baryta, and rock-salt show no trace of inherent radio-activity, and may therefore be used as screens against the universal radiation. The diminution of the ionisation in the mine amounted to 28 per cent. It is possible that different materials absorb the universal radiation to a different extent, and that secondary radiations of various kinds are excited in them. That the β-rays are not confined to radio-active substances proper is shown by J. J. Thomson's observation, according to which the metals of the alkalies emit electrons in the dark and cold, and also when vaporised. E. E. F.

718. *Radiation from Polonium.* **P. Ewers.** (Phys. Zeitschr. 7. pp. 148–152, March 1, 1906. Phys. Inst. d. techn. Hochschule, München, Dec., 1905.) —The positive charge carried by the α-rays emitted by polonium is investigated by the method employed by J. J. Thomson [Abstract No. 746 (1905)] and E. Rutherford [Abstract No. 2170 (1904)], of removing the slowly moving β-rays by means of a transverse magnetic field, and is elaborated, several quantitative results being obtained. A copper sheet coated with

polonium preparation is placed beneath a parallel copper sheet which is connected to the electrometer. Immediately above the polonium sheet is a brass vessel divided by vertical divisions into a number of square cells in such a way that only the rays which make an angle greater than 55° 20′ with the polonium sheet can escape these dividing walls and reach the insulated plate. This brass vessel is surrounded by a cylinder of sheet iron to cut off the transverse magnetic field from the space within it. With no magnetic field the insulated plate slowly acquires a positive change, but as an increasing magnetic field is applied, the rate increases at first and then becomes practically constant. The constant rate of charging is reached when the slowly-moving β-rays, which are negatively charged, describe circular paths and fail to reach the insulated plate. The more slowly moving α-rays are unaffected by the magnetic field. The author disagrees with F. Soddy [see Abstract No. 747 (1905)] that the α-rays acquire their positive charge while travelling through the rarefied gas, because on raising the polonium-coated plate to a high potential no perceptible increase in the rate of charge occurs, and by increasing the gas pressure a diminution occurs. Hence the author considers that the α-rays are emitted by the polonium as positively-charged ions. The author next brings the polonium plate to a negative potential, which he varies until the rate of gain of positive charge by the insulated plate is reduced to zero. The deviation of the negative electrons by the magnetic field is then neutralised by the electrostatic field, and from the values of the two fields and the dimensions of the apparatus he finds that for these negative electrons, $e/m = 1{\cdot}48 \times 10^7$ and velocity $= 8{\cdot}25 \times 10^8$ cm. per sec., which is of the same order as the velocity of the slowly moving kathode rays first observed by P. Lenard [see Abstract No. 1883 (1902)]. From the rate of gain of positive charge by the insulated plate when all the β-electrons are sifted out by the magnetic field, it is estimated that each sq. cm. of the polonium preparation emits $5{\cdot}1 \times 10^7$ α-particles per sec.

S. G. S.

719. *The Effect of High Temperatures on Radium Emanation.* **W. Makower.** (Roy. Soc., Proc. Ser. A. 77. pp. 241–247, March 6, 1906.)—In view of the conflicting conclusions reached by Curie and Danne [see Abstract No. 1360 (1904)] and by Bronson [Abstract No. 1586 (1905)], on the effect of heat on radium emanation, experiments were undertaken to investigate the influence of temperature on the activity of radium emanation when in radio-active equilibrium with radium A, B, and C, and when sealed up in a quartz tube so that there was no possibility of the escape of any volatile product. The results show clearly that the activity as measured by the β- and γ-rays can be changed by high temperatures. This may be due to an increase of the rate of decay of radium C at high temperatures, but may possibly be caused by an alteration in one or more of the other radio-active bodies present. The emanation from 5 mgm. of radium bromide was sealed up in a quartz tube and its activity measured by observing the ionisation produced in a cylindrical metal vessel when the tube was placed opposite its end. The α-rays were absorbed by the quartz tube and the bottom of the ionisation vessel. The quartz tube was heated at intervals in a furnace, and after heating its activity was found to fall off. The emanation, however, recovered its normal value in about 1 hour, showing that the observed decrease in activity was not due to porosity to the emanation of the quartz tube when hot. The change in activity increases with rise of temperature, being small at 1,000° C. and increasing up to 1,200°. The effect increases with the time of heating for about the first hour, but subsequent heating is without effect. J. J. S.

REFERENCES.

720. *Photographic Screens.* **J. Renaux.** (Comptes Rendus, 142. pp. 38-40, Jan. 2, 1906.)—A procedure is described for obtaining, by calculation, a screen suitable for use with a given make of photographic plate. G. E. A.

721. *Demonstration of the Abbe Theory of the Microscope.* **A. Winkelmann.** (Ann. d. Physik. 19. 2. pp. 416-420, Feb. 8, 1906.)—The diffraction image of a small luminous disc, formed by a cross-grating with horizontal and vertical lines, is star-shaped, and, by interposing and rotating a slit of suitable width, different parts of this image are cut off. The objective reproduction of this effect can be demonstrated to a large number of persons by means of an arc lamp, slit, lens, grating, lens and screen, the effect being visible to a distance of 12 m. G. E. A.

722. *Atmospheric Refraction.* **P. Pizzetti.** (Accad. Lincei, Atti, 15. pp. 73-81, Jan. 21, 1906.)—A formula for atmospheric refraction in terms of zenith distance is obtained without any assumption concerning the variation of temperature with altitude, except that the temperature does not increase with the altitude. The maximum errors at zenith distances of 45°, 60°, and 75° do not amount to more than 0·00075″, 0·0069″, and 0·239″ respectively. S. G. S.

723. *Optical Properties of Active Crystals.* **H. C. Pocklington.** (Ann. d. Physik, 19. 2. p. 439, Feb. 8, 1906.)—The author has recently put forward an explanation of the optical properties of active crystals. To this W. Voigt has raised the objection that it would give different velocities in opposite directions. The reply here made is that the velocity formulæ for magnetic and natural activities are each even functions of the direction, and thus give the same value for the velocities in the opposite directions. [See also Abstracts Nos. 31 (1902) and 313 (1906).] E. H. B.

724. *Theory of Spectra.* **I. Fredholm.** (Comptes Rendus, 142. pp. 506-508, Feb. 26, 1906.)—With certain hypotheses the author gives a theory wherein the frequencies of the fundamental vibrations of the molecules approach a limit that is not zero, and it appears that a certain function occurring in the calculation may be chosen in an infinite number of ways so that the resulting frequencies proceed according to a law identical with that for the rays of a given spectrum. R. E. B.

725. *Determination of the Rare Gases Present in Natural Gases.* **C. Moureu.** (Comptes Rendus, 142. pp. 44-46, Jan. 2, 1906.)—A description of an apparatus for the spectroscopic examination of mixtures of natural gases to test for the presence of the rare gases. E. C. C. B.

726. *The Phenomena of Phosphorescence.* **A. Debierne.** (Comptes Rendus, 142. pp. 568-571, March 5, 1906.)—The author takes the view that all phenomena of phosphorescence are due to the change of one body to another under the influence of the exciting cause and that the luminescence is produced during the reverse change. E. C. C. B.

727. *Radio-activity of the Deposits from the Thermal Springs at the Institutes of Bagni di Lucca, Tuscany.* **G. Magri.** (Accad. Lincei, Atti, 15. pp. 111-118, Jan. 21, 1906.)—The electroscope and method of experimenting are described, and then follow the results. The deposits from the tanks of the various institutes are all radio-active, that which is adherent to the sides and which requires force to detach it being in all cases more radio-active than the soft deposit that settles at the bottom. The radio-activity is in some cases as great as that of a sample of pitchblende used by the author. S. G. S.

HEAT.

728. "*Crompton*" *Electrical Pyrometer.* (Electrician, 56. pp. 808–809, March 2, 1906.)—Describes a form of thermoelectric pyrometer with an indicating galvanometer reading in temperatures direct. The special features of the instrument are the use, for temperatures up to 1,100° C., of a couple consisting of a nickel rod running down the centre of a steel tube without touching it, the two being welded together at the hot end and furnished with connecting clamps at the other end. For temperatures below 500° a copper-constantan couple is used. The indicating instrument is of the sector pattern, and has a scale 10 in. long; the scale is constructed to take account of the effect of variations of the temperature of the indicator; this temperature is read by means of a small thermometer attached to the face of the instrument, and five scales are provided corresponding to temperatures 10, 15, 20, 25, and 30° C. respectively. W. Ros.

729. *Method of Determining Thermal Conductivity.* **F. A. Laws, F. L. Bishop,** and **P. McJunkin.** (Amer. Acad., Proc. 41. No. 22. pp. 457–464, Feb., 1906. Contribution from the Phys. Lab. of the Massachusetts Inst. of Technology.)—To insure (1) uniform flow of heat, (2) absence of radiation corrections, (3) exact determination of temperature-differences, (4) exact determination of the flow of heat, (5) independence of the density and specific heat of the metal, the latter is wrought into the form of a hollow spherical shell, its interior is electrically heated, and the temperature-differences are measured by thermoelectric junctions formed by the metal itself and other metallic coatings electrically deposited upon it. Then when the steady state is attained the conductivity $K = Q(r_2 - r_1)/4\pi r_1 r_2(t_1 - t_2)$, where Q is the flow of heat and t_1, t_2 the steady temperatures of the bounding walls of respective radii r_1, r_2. Experiments were made on a shell of cast iron 1·4327 in. thick and of 6·0022 in. diam., the surfaces of which were plated with copper to a depth of 2 mm.; this was filled with a special distilled petroleum oil, which was heated by an electric coil and kept well stirred by two rotating fans, and the external surface was kept at a constant temperature in a bath of the same oil. The electric arrangements for generating heat and for measuring temperatures are fully described, and also the method of procedure. The experiments—which from the dates given were made in 1898—gave 0·1269 as the conductivity of cast iron at 42·1°, with a temperature-coefficient of about −0·0005. R. E. B.

730. *Standardising Thermometers below* 0° *C.* **T. W. Richards** and **F. G. Jackson.** (Amer. Acad., Proc. 41. No. 21. pp. 451–454, Feb., 1906. Contribution from the Chem. Lab. of Harvard College.)—A method of standardising thermometers below 0° C. is described by the authors. The freezing-points of a number of dilute solutions of hydrochloric acid in water were accurately determined by means of a very sensitive standard thermometer, made by Baudin, and reading to −12° C. By means of these results it is possible to standardise any other thermometer, comparing the temperature registered by the uncertain thermometer for the freezing-point of the hydrochloric acid-water mixture, with that registered by the standard thermometer for the same solution. The authors show that the method is both practically and theoretically satisfactory. F. J. B.

731. *Transition Temperature of Sodium Bromide: a new Fixed Point in Thermometry.* **T. W. Richards** and **R. C. Wells.** (Amer. Acad., Proc. 41. No. 20. pp. 435–448, Feb., 1906. Contribution from the Chem. Lab. of Harvard College.)—The authors have determined the transition-point of $NaBr, 2H_2O \rightleftarrows NaBr + 2H_2O$, for use as a fixed point in thermometry. They find it to be 50·674° on the hydrogen scale. [See also Abstract No. 901 (1903).] A. F.

732. *Ratio of the Specific Heats for Mixed Gases.* **F. Richarz.** (Ann. d. Physik, 19. 3. pp. 639–642, March 2, 1906.)—The density, isometric specific heat, and gaseous constant at given pressure and temperature of a mixture of two gases in the mass ratio $1 - \mu : \mu$ are given by—

$$\rho^{-1} = (1 - \mu)\rho_1^{-1} + \mu\rho_2^{-1}, \quad c = (1 - \mu)c_1 + \mu c_2, \quad \rho R = \rho_1 R_1 = \rho_2 R_2 = p/T,$$

whence—

$$(\lambda - \lambda_1)/(\lambda_2 - \lambda_1) = (\rho - \rho_1)/(\rho_2 - \rho_1),$$

where $C/c \equiv 1 + 1/\lambda$, &c.: the ratio of the specific heats is thus expressible as a simple function of the density. Assuming the value of this ratio to be 1·396 for pure oxygen, and applying this theory to the mixtures of oxygen and ozone investigated by Jacobs by means of Kundt's sound-figures, we find the ratio to be 1·29 for ozone. R. E. B.

733. *Explosives.* **A. Noble.** (Roy. Soc., Phil. Trans. 205. pp. 201–236, Sept. 23, 1905. Proc. Ser. A. 76. pp. 381–386, Aug. 4, 1905. Abstract.)—This is a continuation, with apparatus greatly improved and of much greater delicacy, of the author's earlier research in conjunction with Abel, the explosives now examined being cordite, modified cordite, and nitro-cellulose. A full description of the apparatus employed in firing the explosive, collecting, measuring, and analysing the gaseous products, determining the heat generated, and automatically registering the time required for the explosion, the variations of pressure accompanying it, and the rate of communication of heat from the gases to the walls of the explosion chamber is given. The author's former opinion, contested by Berthelot, was fully confirmed, that the transformations brought about by the explosion cannot be represented by a chemical equation even though complicated. The explosions took place with densities of charge from 0·05 to 0·45 under pressures from 442 to 8,064 atmos. with cordite, from 412 to 6,587 atmos. with modified cordite, and from 511 to 6,174 atmos. with nitro-cellulose. The transformation on firing all three substances appears to follow the same general laws: thus, with increase of pressure there is at first a slight increase, and afterwards a steady decrease in the volume of permanent gases produced; but in the volume of the total masses produced this initial increase is much less marked with cordite and is practically non-existent with the other substances; with increase of pressure there is further (i.) a large increase in the volume of CO_2 produced and a large decrease in the volume of CO, (ii.) a marked decrease in the amount of H_2 produced but an enormous increase in methane, (iii.) no practical variation in the amounts of N_2 and H_2O produced, (iv.) a slight decline at first in the amount of heat generated and then an increase which rapidly rises with the pressure. The specific heats of the products of explosion were calculated from the values for the various gases usually assigned, and ranged from 0·224 to 0·239, and the temperatures of explosion were determined by dividing the heat produced per gm. by these specific heats: they varied from 5,086° to 5,749° C. with cordite, from 3,996° to 5,027° with modified cordite, and from 3,362° to 4,283° with nitro-cellulose; these estimates are, however, only provisional. The mean approximate potential energies are 0·9762 for cordite, 0·8387 for modified cordite, and 0·7464 for nitro-cellulose, that for cordite at a density of 0·5 being taken as unit. The erosion produced by the explosives is found to be independent of the pressure and to be governed practically by the heat developed. (Roy. Soc., Proc. Ser. A. 76. pp. 512–514, Dec. 6, 1905.)—This is a note supplementary to the previous papers. Herein use is made of Holborn and Austin's determinations of the specific heat of gases at high temperatures [see Abstract No. 765 (1905)] to recalculate the specific heats of the products of explosion and to re-estimate the temperatures of explosion. The former vary between 0·244 and 0·252, and the explosion-temperatures, calculated as before, vary from 4,670° to 5,268° with cordite, from 3,830° to 4,624° with modified cordite, and from 3,255° to 3,954° with nitro-cellulose. The temperatures, however, as calculated from the dilatability formula, $t = (p/p_0 - 1)/0{\cdot}00367$, vary from 2,775° to 5,275° with cordite, the two methods giving practically the same estimate for the higher densities but being completely at variance for the lower, which may be due to dissociation of CO_2 and aqueous vapour at the lower pressures. The temperatures are, however, really such as to fuse and volatilise C, Pt, Ta, Os, Ti, more or less. R. E. B.

734. *Pressure of Explosions.* **J. E. Petavel.** (Roy. Soc., Phil. Trans. 205. pp. 357–398, Dec. 30, 1905. Proc. Ser. A. 76. pp. 492–494, Dec. 6, 1905. Abstract. Engineering, 81. pp. 429–433, March 30, 1906.)—Pressures ranging from 100 to 1,800 atmospheres were employed, and the explosion of cordite was especially studied. The rise of pressure during explosion was photographically recorded, and the effects of fineness of the material and of difference in shape of the enclosure were investigated. The combustion of cordite is found to proceed according to parallel surfaces, the rate of travel of the flame being proportional to the pressure. Increase in fineness decreases the period for complete combustion, but the curve of pressure is practically independent of the fineness if plotted with this period as unit of time, so that with cordite in even the finest state of division the effect is always distinct from that of a detonation. The maximum pressures observed are in close agreement with those found by Noble [see preceding Abstract]; they conform to formulæ deduced from the theory of gases, but are of less than the normal value in enclosures with surfaces considerable as compared with the volume if the diam. of the cordite is large. The rate of cooling is found to depend essentially on the thermal conductivity of the enclosure and not on that of the gas, and it is proportional nearly to the square of the surface of the enclosure, the inner walls of which attain very high temperatures. If the explosion takes place in a long vessel, wave-action is frequently set up, which is enhanced if the explosion is distributed non-uniformly. R. E. B.

735. *Application of the Statics and Kinetics of Monocyclic Systems to the Theory of Elasticity.* **P. Ehrenfest.** (Ann. d. Physik, 19. 1. pp. 210–214, Jan. 18, 1906.)—In his paper on this subject [see Abstract No. 377 (1903)]

Reissner includes, in his expression for the Lagrange force corresponding to the non-cyclic co-ordinate p, what he calls the *frictional* term—$\dot{p}E(p)$, but he does not give the details of his calculation. The author gives a calculation from which it appears that the function $E(p)$ vanishes, and moreover concludes that the adiabatic changes of the non-cyclic co-ordinates of a monocycle bear no analogy to the phenomena of viscosity in ideal gases. He further points out that Poincaré has misunderstood Helmholtz's views as to irreversible processes. R. E. B.

736. *Planck's Theory of the Irreversible Processes of Radiation.* **P. Ehrenfest.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1301–1314, Oct., 1905.)—It is contended that Planck has identified two functions, denoted by Σ, without giving any sufficient reason, calling them *the* entropy of the system. The author offers a proof that one of these functions as defined does not answer to the conditions laid down by Planck (as, for instance, giving rise to a unique spectrum in the stationary state) unless it is subject to a further particular condition which is one to which the other function is by definition made subject. In this case there are two functions which, while the energy remains constant, continuously increase till they assume a constant value, but they are not therefore necessarily identical. Further, to prove that a stationary state has ensued it is sufficient to examine one of these functions; but for the occurrence and character of a unique state (*e.g.*, a particular spectrum) to be known it must have been proved that the function only ceases to grow when this unique state is arrived at. R. E. B

737. *Internal Pressure of Fluids.* **E. H. Amagat.** (Comptes Rendus, 142. pp. 371–377, Feb. 12, 1906.)—Two expressions have been proposed to represent the so-called *internal pressure* of a gas, viz., $\pi \equiv t\partial p/\partial t - p$ and $w \equiv \Sigma . Rr/3v$, where $\frac{1}{2}\Sigma . Rr$ is the internal virial. The virial equation $K = \frac{3}{2}(p + w)v$ gives $w = (p_0 v_0 - pv)/v$, if the mean kinetic energy K is taken to measure the temperature t and $\Sigma . Rr$ is negligible in the state p_0, v_0, t; and this value for w may also be deduced from other simpler considerations. Now Amagat's experiments on gases show that π and w thus measured may differ by several thousand atmospheres, whereas Clausius's expression for the heat absorbed in an elementary transformation, viz., $f(t)dt + (p + w)dv$, makes them equal. Further, the constitution of fluids is represented very approximately by $\partial p/\partial t = F(v)$, *i.e.*, by $p = tF(v) - \lambda(v)$, which gives $\pi = \lambda(v)$ and $w = t\psi(v) + \lambda(v)$, two very different relations which are in close accord with the experimental results. Hence Clausius's expression must be at fault, and really as to both of its terms. Not only does w seem to be the better representative of what we can conceive as internal pressure, but with it for internal pressure Amagat has succeeded in finding a characteristic that represents the whole of his experimental results for CO_2, both liquid and gaseous and in the saturated state, whereas with π he could get nothing satisfactory. R. E. B.

738. *The Function H in the Theory of Gases.* **O. Postma.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 602–611, Feb. 7, 1906. Proc. 8. pp. 630–639, Feb. 21, 1906.)—The author contends that Boltzmann is wrong in considering that velocity-distribution to be the most probable for which H is minimum, and that when he speaks of a transition from probable to improbable states he really means a transition from stationary to non-

stationary states ; he allows that Maxwell's distribution is the most probable if the *à priori* chance of the occurrence of every velocity is the same, but he denies this hypothesis, giving his reasons for concluding that in space at large the mean velocity is infinitely great. The doctrine that Maxwell's law holds in the stationary state is not touched by this criticism. The author further thinks that, though Jeans has made an important improvement in the theory by showing that the chance is very great of the occurrence of a state which differs but very little from the most probable state, the same character of objection may be made to his general reasoning as to Boltzmann's. R. E. B.

739. *Exact Signification of Carnot's Principle.* **L. Fredey.** (Comptes Rendus, 142. pp. 513–515, Feb. 26, 1906.)—Considering ordered and non-ordered motions with respect to electrons on the hypothesis that, other things being equal, the formation of ordered systems is the less frequent the more complex the systems are and the larger their size, the author concludes that there is no fundamental difference between them ; also that Carnot's principle is purely statistical, and, representing the principle of inertia in reference to groups, is not subject to any restriction, but, while opposing the spontaneous immediate recurrence of phenomena, admits of all orders of recurrence and all kinds of repetition due to interaction. R. E. B.

REFERENCES.

740. *Testing of Clinical Thermometers.* **C. W. Waidner** and **L. A. Fischer.** (Bureau of Standards, Bull. 1. 2. pp. 275–289, Feb., 1905. Zeitschr. Instrumentenk., Beib. 1. pp. 8–11, Jan. 1 ; 2. pp. 18–19, Jan. 15 ; 3. pp. 28–30, Feb. 1 ; 5. pp. 48–50, March 1 ; 6. pp. 58–59, March 15 *et seq.*, 1906.)—Deals with the methods of the Bureau of Standards.

741. *Elimination of Thermometric Lag in Calorimetry.* **W. Jaeger** and **H. v. Steinwehr.** (Zeitschr. Phys. Chem. 54. pp. 428–432, Jan. 30, 1906. Communication from the Phys.-Techn. Reichsanstalt.)—Richards and Lamb [see Abstract No. 1602 (1905)] appear to have overlooked the platinum resistance thermometer described by the authors [see Abstract No. 808 (1904)], which when slightly modified by enclosing the wires in fine metal tubes obviates all the errors in question. Experiments with this thermometer conclusively confirm the validity of Newton's law of cooling for small differences of temperature between the calorimeter and its surroundings. W. H. Si.

742. *Partition of Energy.* **W. F. Magie.** (Science, 23. pp. 161–178, Feb. 2, 1906. Address to Section B Physics, Amer. Assoc. for Advancement of Science, New Orleans, 1905.)—A review of the hypotheses put forward on this subject by Maxwell, Boltzmann, Kelvin, and Jeans, the theories being tested by comparison with experimental results as to the values of the ratio of specific heats. E. H. B.

743. *Theory of the Brown Motions.* **A. Einstein.** (Ann. d. Physik, 19. 2. pp. 371–381, Feb. 8, 1906.)—This is a continuation of a former paper [see Abstract No. 1909 (1905)] in explanation of the motion of particles suspended in a liquid as due to the unordered heat-motions of the molecules of the liquid. For a spherical particle of radius a he finds that its mean displacement and mean rotation in time t are respectively $\sqrt{[t(RT/N)/3\pi ka]}$ and $\sqrt{[t(RT/N)/4\pi ka^3]}$, where RT is as usual, N the actual number of molecules in a gm.-molecule, and k the viscosity. R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

744. *Conference on Electric Units.* (Internat. Konferenz über Elekt. Masseinheiten, Verhandl. pp. 4–67, 1906. Report to Meeting at the Physikal.-Techn. Reichsanstalt, Charlottenburg, Oct. 23–25, 1905. Elektrotechn. Zeitschr. 27. pp. 237–240, March 8, 1906. Electrician, 56. p. 832, March 9, 1906. Abstract.)—This meeting resulted from the International Electrical Congress at St. Louis in 1904. The formal decisions arrived at are to the effect that only two electrical units (the ohm and the ampere) shall be chosen as fundamental. The international ohm to be defined by the resistance of a column of mercury, but the method which avoids the end-correction is not to be employed. The Reichsanstalt will communicate with Messrs. Schott and Co., of Jena, in order to determine whether glass tubes of sufficiently uniform section can be produced of the glass 59^{III}. The tubes are to be carefully annealed, the length measurements made as far as possible at 0° C. with the aid of contact pieces, and when determining the mass of mercury which the tubes will contain, the filling is to be in vacuum without heating. The Kohlrausch differential galvanometer method, the Thomson double bridge method, and that of the potentiometer may be employed for the comparison of mercury resistances. The second fundamental and electrical unit, the international ampere, shall be defined by the deposition of silver, but the Conference expresses the opinion that the information laid before it is not sufficient to enable it to completely specify the silver voltameter nor to propose any alteration in the formally accepted value for the ampere. It is decided that the Weston cadmium cell shall be adopted as the standard cell; that it shall contain solid hydrated cadmium sulphate and an amalgam containing from 12 to 13 per cent. Cd. Sources of disturbance at the negative pole are to be avoided. The cell is not completely specified, the information before the Conference being insufficient for that purpose. The proposals made by the Reichsanstalt are included in the paper, as also are the suggestions from the National Bureau of Standards, and a paper by Carhart on the choice of the second fundamental electric unit; in this latter paper the volt is preferred to the ampere. The minutes of a meeting held in Oct., 1905, of the Electrical Standards Committee of the British Association are printed and record unanimous agreement on the choice of the two fundamental units, the unit of resistance and the unit of current being decided on. The question of the best material for use in the construction of wire standards of resistance was discussed at the Conference, but no formal decision arrived at. In an appendix a table of values is given of the manganin standards of the Reichsanstalt [see Abstract No. 299B (1906)] and the values in 1885 and 1905 of the mercury standards of resistance constructed by Benoit [see Abstract No. 370 (1906)]. F. E. S.

DISCHARGE AND OSCILLATIONS.

745. *Polarisation produced by Electric Current in Gases, and Unipolar Conduction in an Ionised Gas.* **F. Willaert.** (Annal. Soc. Sci. de Bruxelles, 30.

pp. 67–112, 1905–1906.)—The failure of earlier experimenters to obtain direct evidence of a back-e.m.f. due to polarisation in the case of discharge through a gas is explained by the author by the fact that as soon as the e.m.f. producing the current ceases, ionisation ceases, and any existing back-e.m.f. is far too small to cause a current to flow through a circuit which necessarily contains the gas in the tube itself. He therefore produces the ionisation continuously by secondary means—in this case the high-voltage oscillatory discharge due to a Tesla coil. The discharge tube is provided with three pairs of electrodes; one in the middle of the tube for producing ionisation and one at each end, one of these being merely used to check the observations made by the other. In all cases a current is sent through the gas from one electrode to another, and the polarisation current and e.m.f. are determined for various gas pressures, voltages, and polarising currents. On establishing a p.d. between the electrodes, the current does not reach its maximum value for about 30 sec.; on rapidly reversing the direction of the current a greater value is momentarily obtained, but this falls in about 30 sec. to its previous steady value. If the battery be switched out and a galvanometer in, a polarisation current is observed which rapidly falls, but which is appreciable for 4 or 5 min.; the rate of decay is greatest at low pressures, and greater in hydrogen than in air. The polarisation e.m.f. is determined by three methods: (i.) by finding the steady current with continuous e.m.f., in which case the polarisation e.m.f. has effect; and the steady current with alternating e.m.f., when the polarisation e.m.f. has no time to reach an effective value; (ii.) by suddenly cutting the battery out and switching the galvanometer in, the measurements being either ballistically or statically made; (iii.) by a compensation method which is similar in character to the ordinary potentiometer. The three measurements give results in fair agreement, but it should be noted that they are all so uncertain that they serve only to establish the effects qualitatively and not to measure them quantitatively. The nature of the metal and of the gas has a slight influence on the polarisation when this is produced by given current at given voltage, but the e.m.f. of polarisation produced by given current is independent of the chemical nature of the electrodes. Test experiments with weak electrolytic solutions and with non-polarisable electrodes give effects in the former case analogous to those in ionised gases, but not so in the latter case. A paper dealing with the effect of the electrodes then follows, and although the results are not very definite, the author has been able to show that pairs of different metals placed in the ionised gas exhibit unipolarity. He has arranged the metals in a series and finds that those which are less dense are electropositive to those having the greater density. S. G. S.

746. *Recombination of the Ions of Saline Vapours.* **G. Moreau.** (Comptes Rendus, 142. pp. 392–394, Feb. 12, 1906.)—Saline vapours ionised by heat justify by all their properties (saturation currents, &c.) the hypothesis that the separate charges are carried by a number of electrified centres, some positive, the others negative, with a charge equal in absolute value to the transport value for hydrogen. Consequently, a recombination takes place according to the law $dn/dt = -an^2$, where n is the density of the positive or negative charges, and a the coefficient of recombination. The method used in the experiments described is as follows: A current of air passes through a salt solution where it is charged with the salt. This salt is vaporised and ionised in a porcelain tube heated to a red heat, and then passes through a brass tube A. The densities n_1 and n_2 of the positive or negative charges are

determined in two parts of the tube A. The saturation currents between the two parts of A and a concentric cylindrical electrode B are then found, and α calculated. By varying the concentration of the solution and the distance of the system (A, B) from the region of ionisation, values of α were obtained for different concentrations and temperatures of the gaseous current. The following were the results obtained, the concentration of the solution being expressed in gm.-mol. (M) per litre, and the values of α in electrostatic units :—

Concentration	=	M	$\frac{M}{4}$	$\frac{M}{16}$	
		α.	α.	α.	ϵ.
KI	80° C.	415	795	1324	0·63
	15	78	157	—	0·77
KCl	80	410	811	1576	0·56
	15	106	170	—	0·94
KBr	80	421	843	1552	0·56
	15	84	202	—	0·99
KNO_3	80	348	763	1408	0·65
	15	89	200	—	1·00
RbCl	80	—	—	1216	0·73
	15	—	—	141	0·89

From these results it follows that at a given temperature the coefficient of recombination varies sensibly as the inverse of the square root of the concentration. It diminishes as the temperature falls. The values of ϵ (the ratio of the number of recombinations to the number of collisions) were calculated from Langevin's formula $\epsilon = \alpha/8\pi K$. [See also Abstract No. 351 (1906).]

A. W.

747. *Canal Rays.* **C. Füchtbauer.** (Phys. Zeitschr. 7. pp. 153–157, March 1, 1906.)—The author proves that canal rays, impinging on metals in hydrogen on the farther side of the kathode, cause them to give off negative electricity, but that in addition to this some metals reflect the canal rays to a very perceptible extent. Behind the perforated kathode he mounted a circular diaphragm consisting of six sectors, five of them covered with various metals and the sixth open. The diaphragm could be turned by means of a magnetic contrivance, and was so arranged that each sector could in turn be brought before the canal-ray tube. But for a small aperture, the diaphragm was completely enclosed in a metallic cylinder, which could be earthed. When the open sector was presented to the canal rays they penetrated into the cylinder and gave up their charges to it. But on interposing one of the metallic sectors the canal rays were reflected, and they and the electrons issued from the cylinder. By deflecting the electrons the two constituents could be estimated separately. The author found that at high voltages (30,000) all metals give off electrons, in the same order as Volta's series. Pt gives off least, and Al gives off four electrons for each canal-ray particle it receives. Pt, Ag, and Cu reflect 10 per cent. of the incident canal rays, even at the highest voltages. Since in the glow discharge canal rays impinge upon the kathode, the negative secondary radiation here discovered must have a profound influence upon the kathode-fall, which is produced by the withdrawal of negative ions from the region in front of the kathode by the current itself.

E. E. F.

748. *Ionisation by Röntgen and Kathode Rays.* **J. Herweg.** (Ann. d. Physik, 19. 2. pp. 333–370, Feb. 8, 1906. Extract from Dissertation, Würzburg. Écl. Électr. 46. pp. 493–496, March 31, 1906.)—Quantitative measurements show that the ionisation produced by Röntgen rays does not vary with the temperature, nor does it affect the simultaneous ionisation produced by an incandescent metal, both effects being simply superposed. The ionisation is the same at all temperatures up to 400° C. at least. Both Röntgen and kathode rays bring about a reduction of the discharge potential of the glow discharge. The effect of the rays depends upon the pressure and upon the volume between the electrodes, rising with increasing volume and pressure. Discharge sets in at an electrode when the voltage over the mean free path equals the ionisation voltage of the positive ion. Anything, therefore, that increases the voltage over the mean free path reduces the discharge potential. Such an increase is brought about by ionisation, which concentrates the lines of force upon the space between the electrodes. The ions in question are positive atoms and electrons. This is proved by the action of a magnetic field upon the dependent current through a gas ionised by Röntgen rays. It is found that the field increases the current density. Theoretical considerations show that this is due to the strong deflection of the ions, which, owing to their increased path, have increased opportunities of producing secondary ionisation. These ions are free electrons. Their cycloidal path may be exhibited by combining a magnetic and electric field. With a magnetic field of about 100 units, and a voltage of 10,000, the kathode rays issuing into an observation tube are caught on a phosphorescent screen. On displacing the screen along the tube, the patch is gradually displaced towards one side, and at a certain point it stops and reappears on the other side. By tracing out these displacements it is found that the path is a cycloid with a rolling circle having a radius of 1·5 cm. E. E. F.

749. *Origin of Canal Rays of Large Mass.* **E. Gehrcke.** (Phys. Zeitschr. 7. pp. 181–182, March 15, 1906.)—The hypothesis is put forward that the bodies of large mass in the canal rays are dust products (Zerstäubungsprodukte) of the kathode, which when given off are negatively charged, and which soon lose a negative electron owing to their exposure to ultra-violet light. This Hallwachs-effect influences not only the particles emitted by the kathode, but also the kathode itself. These comparatively large masses have in some cases, according to W. Wien, a molecular weight of 650 [see Abstract No. 1728 (1904)], and the author suggests that they might be rendered visible by the method of H. Siedentopf and R. Zsigmondy [Abstract No. 1169 (1903)]. The magnetic "spectrum" produced at constant p.d. would be easily explained on this hypothesis, since the mass of these bodies would probably not be uniform. The fact that rays similar in properties to the canal rays exist on the side of the kathode which faces the anode, as was shown by E. Goldstein [Abstract No. 2252 (1902)], and called K_1 rays, is still further evidence in favour of the above view. The author then suggests that the spectrum of the metal of the kathode should exhibit the Doppler effect, exactly as in the case of the canal rays, which exhibit the hydrogen spectrum, as shown by J. Stark [Abstracts Nos. 297 and 521 (1906)]. S. G. S.

750. *Potential Gradient in the Mercury Arc.* **J. Pollak.** (Ann. d. Physik, 19. 2. pp. 217–248, Feb. 8, 1906. Deutsche-techn. Hochschule, Prag, Nov. 12, 1905. Écl. Électr. 47. pp. 55–56, April 14, 1906.)—A continuation of the investigation mentioned in Abstract No. 1462 (1905), in which the potential gradient along the mercury arc in a vertical tube is measured by means of a movable probe electrode and an electrometer. In order to keep the arc from wandering about the surface of the mercury

kathode at the lower end of the tube, this surface is brought to such a level as to just uncover the tip of a platinum wire sealed through the glass and forming an electrical connection. By this means a capillary depression is formed which fixes the foot of the arc column and prevents the troublesome variations in current and p.d. which would otherwise occur. The effect of this is to cause a diminution of 0·76 volt in the kathode-fall, for currents of 5 to 8 amps. In the arc column the potential gradient is uniform, and therefore, as is shown by Poisson's law ($\delta^2V/\delta x^2 = -4\pi\rho$), there cannot be a preponderance of ions of one sign or the other in it. In the dark space about the kathode the potential gradient diminishes to zero, as also in the short dark space near the anode. But immediately at the electrodes it reaches its highest values. Potential curves are given which show that the gradient changes sign after becoming zero in the kathode dark space, but the author thinks this is due to the disturbing effect of the probe. The author next deals with the phenomena that occur during the "striking" of the arc. This is accomplished by first striking an auxiliary arc between the kathode and another mercury electrode at the lower end of the tube. When the ionised vapour so formed has risen sufficiently to condense in globules on the anode, a stratified discharge begins from these globules and spreads over the anode surface, whilst the current at the same time increases. If the resistance in circuit is not too great, the striæ move downward towards the kathode, and when the undermost stria reaches it there is a sudden increase in the current and the discharge becomes an ordinary arc. If the resistance in circuit is kept suitably large, the discharge may be maintained at any desired stage of the transition, and the author has investigated the potential distribution in arcs with varying degrees of striation. Under these conditions the potential curve exhibits a series of waves corresponding with the individual striæ. The amplitude of the waves increases and the length diminishes toward the anode, where the striæ are more crowded, and the author suggests that the anode-fall may in reality be the mean value of a series of widely alternating potentials in a closely packed series of striæ. Toward the kathode the striæ become larger and fainter and the waves in the potential curve die out, the latter becoming horizontal within the dark space. So long as the potential curve exhibited any waves the discharge (with the p.d. used) was not stable and ceased if the necessary ionisation was not provided by maintaining a small auxiliary arc at the lower end of the tube. J. D. C.

751. *Duration of Afterglow produced by Electrodeless Discharge.* **C. C. Trowbridge.** (Phys. Rev. 21. pp. 410–411, Dec., 1905. Abstract of paper read before the Amer. Phys. Soc., Oct. 28, 1905.)—From determinations of the duration of the afterglow at various pressures, it is found that smooth curves connecting these quantities can be obtained. When the electrical intensity is small, the maximum duration is proportional to the minimum sparking potential, the pressure being constant. On changing the capacity in order to alter the frequency of discharge, the maximum of the duration curve is altered to correspond to the displacement of the minimum sparking-potential of the discharge. Change in length of spark-gap alters the curve. At the temperature of liquid air the duration and intensity of the afterglow are diminished. S. G. S.

752. *Duration of Discharge in Röntgen-ray Tubes.* **B. Brunhes.** (Comptes Rendus, 142. pp. 391–392, Feb. 12, 1906.)—A micrometer spark-gap was put in series with the Röntgen-ray tube, and an iron disc, pierced with numerous circular holes 4 to 5 mm. diam., was placed between the tube and a fluorescent screen. When the disc was rapidly rotated, the holes, as seen on the screen, appeared elongated in the direction of motion. With the aid of a single emission of rays, the image of the holes was photographed, and at the same time the holes themselves, by means of the light from the spark-gap. The results show that although, on the plate lighted by the spark, the holes never appear elongated in the direction of motion by any appreciable amount, yet the images of the holes lighted by the Röntgen rays are elongated, the elongation corresponding to a duration of the action of the rays for a period of the order of the ten-thousandth of a second. [See also Abstracts Nos. 1801 (1900) and 568 (1906).] A. W.

753. *Duration of Discharge in a Crookes Tube.* **A. Broca** and **Turchini.** (Comptes Rendus, 142. pp. 445–447, Feb. 19, 1906.)—A criticism of the method of Brunhes [see preceding Abstract] is first given, the authors pointing out that this method can give no definite conclusions relating to the time for which the discharge lasts. A study of the phosphorescence of the glass of the tube by means of a revolving mirror shows that it lasts for a long time, and probably the fluorescence of the platinocyanide exhibits a similar phenomenon. The authors' method consisted in photographing (on specially sensitive plates) a little spark of 5 to 6 mm. introduced into the circuit with the tube and a Villard turbine-interrupter. The image of the spark was thrown on to the plate by a mirror, whose radius of curvature was 1 m. and which was attached to the axis of the interrupter. This latter turned at the rate of 5 revs. per sec. The images obtained were extremely feeble, on account of the feeble light of the spark, but sufficiently strong to permit of measurements being made. The results were the same using blunt points of Fe, Al, or Mg. In all cases the plates show a sharp beginning of the discharge, which remains relatively strong for 0·00025 sec., when it becomes much more feeble, and terminates asymptotically at the end of about 0·0008 sec. This time differs from that obtained electrically (0·0005 sec.) [see Abstract No. 568 (1906)], but is of the same order of magnitude. Probable reasons for this are assigned. These results correspond to the condition of the pure kathode discharge. For tubes of less than a 10-cm. equivalent spark the same form of discharge is obtained, but there is an elongation proportional to the time. The peculiarities of the discharge can be attributed to the ionisation of the sparks. The results point to the existence of a time of discharge characteristic of the state of the tube. A. W.

754. *Magnetic Field and Coronal Streamers.* **J. Trowbridge.** (Amer. Journ. Sci. 21. pp. 189–195, March, 1906.)—In dealing with the phenomena induced by electric discharges in strong magnetic fields, large tubes were most frequently used, so that, with the voltages ranging from 3,000 to 8,000 between the discharge terminals, the currents obtained varied from 5 to 20 milliamps. As it was found that graphite resistances mounted on quartz had large temperature-coefficients and also considerable counter-e.m.f.'s, a column of running water under constant pressure in a glass tube was used instead. At pressures varying from 1 cm. to 1 mm., the kathode light on a circular Al plate 3 cm. diam., forming the pole of a powerful magnet (the magnetic lines of which are directed along the line of electric discharge), is driven to the circumference of the disc, forming to the eye an apparently circular discharge. Photographs of this taken in a rotating mirror show that it is a case of unipolar rotation. The appearances observed strongly suggest the forms seen in the solar corona during a total eclipse. If we suppose that a p.d. can arise between the swiftly moving strata of gases, or from the eruptions which take place mainly along the equatorial belt and the polar regions, the supposed magnetic poles of the sun would undoubtedly tend to cause the resulting electric discharges to revolve about the pole. In observing the effect of a strong magnetic pole on plate terminals in wide tubes of rarefied air at comparatively high pressure under conditions of high e.m.f. and great current density we can observe phenomena of rotation which present a striking analogy to the appearance of coronal streamers. Further, when the magnetic field is at right angles to the line of discharge, distinct streamers are seen to radiate from the magnetic pole. Part of the paper next deals with the influence of a magnetic field on the production of Röntgen rays, the chief conclusions being: (*a*) When the anode in a Röntgen-ray tube is also the end of a powerful electromagnet, the application of the magnetic field results in the production of Röntgen rays from a bulb which cannot be excited without the application of heat; (*b*) when the kathode forms the magnetic pole a violet brush-like light appears on the kathode, on the side away from the magnet, while the fluorescent light is forced somewhat beyond the kathode; (*c*) the use of Leyden jars with coils of over 20 cm. spark-length results in a greatly increased production of Röntgen rays when the magnetic field is applied, and therefore (*d*) the application of a strong magnetic field at the anode with lines of force along the line of electric discharge provides a safe and useful method of regulation of Röntgen-ray tubes, which should be specially valuable for hospital work; (*e*) an electrometer connected to the terminals of the exhausted tube shows a diminution of the apparent resistance when the anode is made the magnetic pole, and a rise in resistance when the kathode constitutes this pole. With Leyden jars in circuit the magnetic pole separates the oscillations, and rectifies the discharge to a certain extent. C. P. B.

755. *Waves of Frequency between Heat and Hertzian Waves.* **R. A. Fessenden.** (Nature, 73. p. 428, March 1, 1906.)—A plano-convex lens is attached at the middle of its plane face to the end of a metallic rod; the middle of the curved face of the lens is then approached to that of a similarly mounted lens. When the metallic rods are connected to the terminals of a high-voltage machine, sparks pass between the middle points of the lenses. The oscillating column is the air between the central points of the lenses, and since this is very small the frequency is great. Quartz lenses behave better than glass ones, as the quartz does not become conducting on being heated by the passage of the spark. S. G. S.

756. *Order of Magnitude of the E.M.F.'s in Receiving Aerials.* **G. Tissot.** (Journ. de Physique, 5. pp. 181–187, March, 1906. Paper read before the Soc. franç. de Physique, Jan. 19, 1906.)—Experiments at various distances, reduced in all cases to 1 km., with identical transmitter and receiver aerials 50 m. long, with a 5-cm. spark and 20 interruptions (taken as number of wave-trains) per sec.; the effective current received on the bolometer was $2{\cdot}7 \times 10^{-8}$ amp., whence, from the ordinary formulæ, the effective e.m.f. ($V_{\text{eff.}}$) is calculated to be 1·75 volts and the maximum e.m.f. (V_0) 610 volts. With aerials of 56 m., and 30 interruptions, $V_{\text{eff.}} = 2{\cdot}5$ and $V_0 = 645$ volts. It is pointed out that these values can only be regarded as a first approximation. Confirmation as regards the order of magnitude was obtained from measurements at the potential loop at the top of the aerial of a receiver station situate at the base of a hillock 50 m. high, the aerial being inclined so as to enter a window in a house at the top of the hill, and its upper end being connected to the needle and one pair of quadrants of an electrometer placed on an upper floor. The other pair of quadrants was connected through a 2-mfd. condenser to an artificial earth consisting of about 10 sq. ft. of wire netting laid on the ground inside the house. The 4-wire transmitter aerial was 54 m. long, the tuned simple receiver aerial 70 m. long (vertical projection 33 m.). The electrometer was adjusted to give 80 divs. for 10 volts (continuous). The signals were of 30 sec. duration to obtain a steady condition. A series of 20 observations gave 16–18 divs., whence $V_{\text{eff.}} = 4{\cdot}6$ volts. $V_{\text{eff.}}$ calculated from the received current ($5{\cdot}7 \times 10^{-8}$ amp.) $= 3{\cdot}8$ volts. But the bolometer had a resistance of 17·3 ohms. By examining the effect of added resistance in series with the bolometer, the current which should be received were the bolometer of zero resistance is found to be $6{\cdot}6 \times 10^{-8}$ amps. From this, $V_{\text{eff.}} = 4{\cdot}4$ volts, which agrees well with the value obtained from the electrometer reading. Experiments with inductive coupling give results of the same order but individually very variable. L. H. W.

757. *Resonance in Wireless Telegraph Circuits.* IV. **G. W. Pierce.** (Phys. Rev. 22. pp. 159–180, March, 1906).—The experiments are continued [see Abstract No. 569 (1906)], the direct method of coupling being now employed (Braun's type in which the condenser discharges through some of the turns of an inductance in the aerial circuit). The transmitter was adjusted until a maximum reading on a hot-wire ammeter between the aerial and ground was obtained, and various forms of receiving circuit were tried. First, the resonance curves were obtained with the receiver tuned by added inductance in series with the aerial. The curves are much more obtuse than was the case with inductive coupling, the deflection dropping to half for a decrease of 26 per cent. or increase of 60 per cent. in the inductance in circuit for maximum deflection [compare Abstract No. 569 (1906)]. This loss in sharpness of resonance is not accompanied by any great gain in intensity of signals, the deflections being only 1·4 times as great as those in the case giving a fall of energy to one half for a 5 per cent. dissonance, with inductive coupling. The tuning is next effected by the use of a variable capacity in shunt to the oscillation galvanometer; and the relation between height of aerial and the resonant inductance and resonant shunt capacity in the two methods is examined. *Relation of integral current received to height of receiving aerial.*—Plotting deflections against height of aerial when the tuning is effected (1) by added inductance, and (2) by a shunt capacity, the curves obtained show that the latter method of tuning gives larger deflections; the advantage increases with increasing height, and in one case the deflections were as 3 : 1. Replotting these curves with ordinates changed by a constant multiplier, the curve of the fourth roots of the deflections obtained by method (2) is a straight line, while that of the *square* roots of the deflections by method (1) is a straight line. So that if tuning is effected by method (1), *i.e.*, added inductance, the current is proportional to the height of the aerial. If tuning is by method (2), *i.e.*, capacity in shunt, the current is proportional to the *square* of the height of the aerial from the "effective ground." It is shown that the resonance conditions are not modified when the receiver is placed in shunt to part of the tuning inductance (equivalent to an inductive shunt to the instrument), but only the received energy is diminished. Experiments to test the image theory of the action of the ground are given in conclusion: good agreement with theoretical predictions. It is found that it is easy to balance the aerial at the receiver with an artificial ground which will increase the reception of energy 20 to 25 per cent. over a good actual ground. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

758. *Polarisation of Standard Cells.* **R. R. Ramsey.** (Phys. Rev. 21. pp. 56–58, July, 1905. Abstract of paper read before the Amer. Phys. Soc., April 22, 1905.)—Cadmium cells made according to the usual formula and of the H form were employed, and a current from a battery was passed through them; the diam. of the mercury electrodes of the cells is about 1 cm. With a current of 4 milliamps. the initial current is proportional to the total e.m.f. in the circuit. The value of the current gradually decreases and reaches a steady value in about 10 min., this latter value being proportional to the e.m.f. of the battery. After remaining constant from 2 to 4 hours, the current rapidly diminishes to an unsteady value near zero. If the circuit is broken at any time after the first decrease, the potentiometer shows the e.m.f. of the cell to be a few hundredths of a volt, but this gradually increases, and after short runs the cell may regain its original e.m.f. to within a few thousandths of a volt. After extended runs the cells recover slowly, in one case the rise being from 0·017 to 0·084 volt in two weeks. If the current is reversed after the cell has been run down the e.m.f. is restored to nearly its normal value. The polarisation was proved to be at the mercury terminal. F. E. S.

759. *Sensibility of Selenium towards Light.* **N. A. Hesehus.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. No. 8, Physics Section, pp. 221–231, 1905. From the St. Petersburg Technological Inst. Phys. Zeitschr. 7. pp. 163–168, March 1, 1906.)—In the author's previous five articles on this subject, published between 1883 and 1903, he developed the formula $i=a(b^m-1)$ and verified it experimentally; he also showed that the residual optical phenomena of selenium are quite comparable to the phenomena of residual elasticity [see Abstract No. 613 (1904)]. He now gives some further details to supplement his previous work and that of Ruhmer [Abstract No. 99 (1903)] and of Pfund and Berndt [Abstracts Nos. 363 and 1513 (1904)]. From the formula $i=a(b^m-1)$ (where i is the intensity of the light, and m [which is equal to $(c-c_0)/c=(r_0-r)/r$] is the relative change of electrical conductivity), it follows that the ratio m'/m (where m' corresponds with $i'=4i$) may vary between 4 and 1 as i varies from 0 to ∞. For feeble illumination (4 c.p.) $m'/m=3{\cdot}6$ according to Ruhmer's data, and for strong illumination (20,000–80,000 c.p.) $m'/m=1{\cdot}2$ or $1{\cdot}14$. The theoretical conclusions are thus completely confirmed by experiment. The two varieties of selenium studied by Ruhmer, viz., hard and soft, may be characterised by the value of m corresponding with 5 c.p.; for the first kind m is less than 1 and for the second greater than 1; the formula above is only applicable to the second variety of selenium ($a=5$, $b=2$). The numerical data of Ruhmer showing the slow variation of the resistance of illuminated selenium may be fairly well represented by the formula $dx/dt=k(n-x)^{\frac{1}{2}}$ or $(n-x)^{\frac{1}{2}}=\mathrm{K}(\mathrm{T}-t)$; here x represents the depth of propagation of the allotropic dissociation of the selenium under the action of the light; n is its limiting value at the time T. At the same time x and m will represent the relative values of the electrical conductivity, $(c-c_0)/c=(r_0-r)/r$. D. H. J.

760. *Measurement of Energy in the Secondary of Induction Coils.* **Wertheim-Salomonson.** (Röntgen Soc., Journ. 2. pp. 27–33, Dec., 1905.)—The author gives fuller particulars as to the method employed in making the measurements described in Abstract No. 1770 (1905). The calorimetric method of determining the energy in the secondary circuit consisted in the employment of a special calorimeter in which slate was used as the resistance material, immersed in liquid paraffin (Netherland's pharmacopœia). A more convenient method is described in which the heating of the slate and the surrounding liquid causes the latter to rise in a capillary tube. The construction of such dilatometers is dealt with, the slate being in the form of a square rod 30 cm. long, and of thickness respectively 9·7, 7, and 4·3 mm. in three models. The dilatometers are standardised by indirect comparison with the calorimeter readings according to the earlier method, the dilatometer and calorimeter being first in series and then in parallel; from the readings, respectively proportional and inversely proportional to the resistance, the ratio of the two resistances is calculated; and knowing the water equivalent of the calorimeter, the watt-seconds corresponding to a rise of 1 cm. in the tube are obtained. For rough experiments the loss of temperature during the experiment may be neglected, and the results are then accurate to about 3–4 per cent. The resistances of the dilatometers were found to be 20 million ohms in the first and 200 million ohms for the third model, the resistance of the coil secondary being negligible in comparison. Experiments with a 12-in. coil and mercury break with the three models show that the greater the resistance in the secondary, the smaller the efficiency. Thus :—

	Dilatometer I.	II.	III.
Watts, primary	49·8	48·5	47·1
Watts, secondary	26·2	22·8	18·8
Efficiency, per cent.	54·7	48	40
Loss in core..................	13·04	16·04	20·38
Loss in copper	9·06	8·66	7·92

The resistance of I., if measured by the equivalent spark, corresponds to a soft Röntgen-ray tube; II., to a hard tube; while III. has a higher resistance than the hardest tube used. To determine the resistance of a focus tube, one need only employ two dilatometers, one in parallel and the other in series with the tube. It is then pointed out that the information furnished by a dilatometer is superior to that given by a milliammeter and stop-watch, the dilatometer giving readings proportional to the total quantity of Röntgen rays given off during the time that the tube is in action. The author's previous measurements of the photographic intensity of discharges have proved that the photographic value rises proportionally to the square of the mean intensity of the discharges, and much faster than proportional to the coulombs, which latter is what the milliammeter and stop-watch method measures. For practical purposes the dilatometer is made less sensitive, and has a resistance of 1 million ohms. The action of a focus tube is defined by the penetration on the Benoist scale, the distance from the plate, and the dilatometer reading. It is finally pointed out that, as shown by B. Walter, the efficiency of a coil is independent of the energy taken up by the primary, and dependent solely on the resistance between the secondary terminals; so that as long as the tube resistance is constant the primary watts supply all the indication necessary as to the energy in the tube. The characteristics of a suitable wattmeter for this purpose are mentioned. L. H. W.

761. *Theory and Calibration of Phase-meters.* **W. E. Sumpner.** (Phil. Mag. 11. pp. 81–107, Jan., 1906. Communicated by the Physical Society, Oct. 27, 1905.)—The theory of phase-meters for multiphase circuits is elegantly worked out by vector mathematics both for balanced and unbalanced loads. The usual assumptions of sinusoidal variations of the

currents and pressures, and of similarity in the electromagnetic properties of the coils of the instrument are dispensed with. It is shown that, apart from mechanical errors, all phase-meters are equally accurate on balanced loads if properly calibrated; that they are independent of frequency and wave form; and that no appreciable inaccuracy is introduced by the use of iron in their construction, if the air-gap is such as is generally required. By the employment of iron as well as by that of dissymmetry in the coils the great advantage of openness in the useful part of the scale may be gained. A method of calibrating phase-meters by direct currents is worked out, and its reliability shown by an example of its application to one of the author's instruments of the iron type. Finally, the error of phase-meters on unbalanced circuits is discussed, and is shown to be serious for badly balanced loads, and to increase rapidly as the power-factor diminishes. On three-phase circuits this error can be theoretically reduced to zero by the use of three current and three pressure coils arranged with mathematical symmetry—a condition which is difficult to ensure in the construction of such an instrument. J. D. C.

762. *Capacity of Mica Condensers.* **A. Zeleny.** (Phys. Rev. 22. pp. 65–79, Feb., 1906.)—The capacity of a mica condenser as determined by the ordinary deflection method is a variable quantity and a function of the period of the galvanometer; it represents neither the unabsorbed free charge nor the otal quantity of electricity held by the condenser. The capacity as determined from the free charge, being independent of the period of the galvanometer, standards of precision must be rated in terms of it. An interval of several hundredths of a second exists between the time of discharge of the free electricity and the liberation of a measurable quantity of the absorbed charge; during this interval the condenser circuit should be open, a key conveniently accomplishing this being described and sketched. With this modification the capacities of good condensers can be determined to within 0·05 per cent. and the mica condenser can be used as a standard of precision. As an illustration of the above statements, discharge curves of two mica condensers and of a paper condenser are given, the residual effect in the latter being very marked. The following definition of capacity is suggested as being more appropriate than that in present use: "The capacity of a condenser is the quantity of electricity it retains, unabsorbed, while its plates are at a difference of potential of 1 volt." F. E. S.

763. *Growth of Current in Coil of Electromagnet.* **B. O. Peirce.** (Amer. Acad., Proc. 41. No. 24. pp. 505–540, Feb., 1906. Contribution from the Jefferson Phys. Lab., Harvard University.)—This paper gives the results of tests made on an electromagnet with a nearly-closed massive iron core, the air-gap being variable. The results are compared with others obtained from a large closed electromagnet having a core finely laminated. A large number of curves illustrate the growth of the current with time in various circuits containing electromagnets, and a discussion is given of the effect of eddy currents in a core of definite constant permeability. F. E. S.

764. *Comparison of Electric Fields.* **D. Owen.** (Phil. Mag. 11. pp. 402–414, March, 1906. Paper read before the Physical Society, June 30, 1905.)—A short wire, suspended by a fine quartz fibre, is vibrated in the electric fields to be compared, it being shown that the frequency of the needle is in simple proportion to the field strength. When the needle vibrates in the field between two parallel plates, its effect in disturbing the field becomes inappreciable when the distance apart of the plates is three times the length of the needle. A glass cylinder was found to shield the needle from the external field. A mica cylinder also exhibits the shielding action, but after dipping it into melted paraffin wax the cylinder transmits the force for some time. On discharging the two plates between which the field was produced, the cylinder is left charged, there being a field in the interior which dies out with time. Ordinary paper has a shielding action, but not paraffined paper. In an alternating field the period of the needle was increased when the latter was surrounded by a glass or mica cylinder. Finally, an instance is given in which the needle is used to measure the p.d. between the two plates, this being proportional to their distance apart and to the frequency of the needle. G. E. A.

765. *Calibration of Gold-leaf Electrometers.* **H. W. Schmidt.** (Phys. Zeitschr. 7. pp. 157–162, March 1, 1906.)—Instead of applying known potentials, the author calibrates a gold-leaf electrometer by times of discharge under the influence of the β- and γ-rays of radium, these times being proportional to the p.d. This is more appropriate, since the instrument is not as a rule used for measuring p.d.'s. The relative p.d. between two scale divisions is obtained by exposure to the radium rays from a preparation fused into the glass wall, and noting the times taken by the leaf to traverse successive divisions. If there is a saturation current, these times are proportional to the p.d.'s. If the shape of the electroscope leaves a doubt as to whether there is a saturation current, it is only necessary to connect the electroscope with an air-condenser which is not too small, and to expose this alone to the radium rays. The author believes that with a well-calibrated leaf electrometer as good results may be obtained as with a quadrant electrometer. It has besides the great advantages of simplicity, small capacity, and independence of external electric disturbances. E. E. F.

766. *Revolving Disc Flux-meter.* **K. T. Fischer.** (Deutsch. Phys. Gesell., Verh. 7. 22. pp. 434–439, Nov. 30, 1905. Paper read before the 77 Naturforscherversamml. at Meran, Sept. 27, 1905.) — Experiments are quoted showing that with a little Faraday disc 3 cm. in diam., driven at 50 to 100 revs. per sec., it is possible to measure magnetic fields down to about H = 10 with a voltmeter or millivoltmeter to an accuracy of about 1 per cent., while with a 5-ohm mirror galvanometer small magnetic fields such as that of the earth can be measured. A practical form of the apparatus is made by Hartmann and Braun. The disc, which has a nett area of 8 sq. cm., is carried on a flat arm about 20 cm. long, and is driven by a silver wire passing over a similar grooved disc actuated by strong clockwork held in the hand. The silver wire serves also to make the contact on the circumference of the Faraday disc, while a platinum-iridium brush makes the inner contact. The internal resistance of the apparatus is 0·56 ohm, but varies 0·1 ohm owing to imperfect connection of the driving wire. When measuring small magnetic fields, a low-resistance instrument may be needed, and the variation of resistance will cause error unless a potentiometer method of measuring the e.m.f. is employed. The speed of the disc is measured either by a counter or by a frequency measurer of the firm's pattern adapted to the purpose. Both of these are included in the frame of the apparatus; and, since the whole is self-contained, the disc can be inserted into any air-gap of at least

8 mm. clear. The clockwork is started by a button, and the flux read off from the voltmeter reading. Thermoelectric effects are eliminated by turning the disc over and taking an average reading. The instrument is superior to the Lenard bismuth spiral for flux measurement, since it is readily standardised and its constant does not alter. D. K. M.

767. *Modified Form of Sella's Magneto-elastic Detector.* **L. Tieri.** (Accad. Lincei, Atti, 15. pp. 164–168, Feb. 4, 1906.)—The detector of Sella [see Abstract No. 2685 (1904)] is of small sensibility. The author has investigated the subject, and as a result has devised a form of this detector which is stated to be more sensitive than a Marconi detector [type and make not stated] in the Physical Institute of the University of Rome. This improvement is brought about by keeping the core circularly magnetised besides applying torsion. The apparatus consists of a core of fourteen 0·5-mm. diam. annealed iron wires 10 cm. long, soldered together at the two ends and placed in a glass tube 9 cm. long and 0·49 cm. external diam. A single layer of 0·05-mm. diam. copper wire is wound on the glass tube for 7 cm. of its length, one end of the winding being free and the other connected to the gas pipe (also attached to spark coil); external to this winding is a narrow coil at the centre of the core, of resistance equal to that of the telephone to which the ends of the coil are connected. One end of the core is soldered to a solid support maintaining the core vertical, and the other end is provided with a lever for applying torsion. The wires of the core form part of the circuit of a battery of Grenet cells (current not stated). When the battery circuit is open the apparatus is insensitive to waves during application of torsion, but with the continuous current flowing through the core, thus circularly magnetising the wires, the characteristic sound in the telephone is heard, if waves are acting, during the whole time the core is being twisted or untwisted. On again interrupting the current through the core, sounds can still be heard on twisting the core, but these rapidly diminish in intensity and finally disappear. If, however, the current is passed through the core and then interrupted after torsion has been applied, on a small twist not exceeding a definite value being given, the intensity of the sound produced decreases to a certain limit, at which the sensibility is greater than in the first case. Whether this sensibility is permanent is not yet certain. The phenomenon is even more marked in the case of nickel. A continuously receptive form of detector has been constructed in which two similar detectors are used whose cores are taken through cycles of torsion and detorsion, but so arranged that one detector is at its most sensitive point when the other is at the "dead" point (zero torsion). This is effected by placing grooved pulleys on the ends of the cores which are to be twisted, and applying, by means of a continuously driven eccentric, a twist up to the limiting angle, springs causing the belt to make the core return, through zero, to the other extreme of the cycle. The apparatus is illustrated, and wireless telegraph messages are said to have been received with it (apparently from a few metres' distance). L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

768. *Heusler's Magnetic Alloy.* **A. Gray.** (Roy. Soc., Proc. Ser. A. 77. pp. 256–259, March 6, 1906.)—Tests were carried out on two rods of a magnetic alloy of manganese, aluminium and copper received from Heusler.

The intensity of the magnetisation (I) was calculated on the assumption that the effective lengths of the specimens were five-sixths of the actual lengths, and the magnetising field H was found by calculating the demagnetising factôr for a cylindrical rod. The first rod contained about 26·5 per cent. Mn, 14·6 per cent. Al, and the remainder Cu. The value of I, when H was 8, was found to be 105. The second rod contained about 16 per cent. Mn, 8 per cent. Al, a little Pb, and the remainder Cu. At first this rod was practically non-magnetic. After being heated, however, to 400° C. in a furnace and allowed to cool slowly, it became magnetic. After being heated to 340° C. for about 20 min. and allowed to cool, it was found to be strongly magnetic. The critical temperature was found to be 350° C. Heated to 400° C. and plunged into cold water the specimen became non-magnetic. An examination showed that several cracks had occurred, and this affected the magnetic tests. It was now cooled to the temperature of liquid air. It was found to be more susceptible to magnetic force and exhibited less hysteresis and retentiveness than in its previous best condition. Analogous curves were obtained from tests of nickel and steel. The research is being continued.

A. R.

769. *Rapid Method of Measuring Magnetic Moment of a Bar Magnet.* **H. Armagnat.** (Rev. Électrique, 5. pp. 134–135, March 15, 1906.)—The magnet is placed horizontally with its axis pointing north and south. In this position there is a neutral point in the line drawn through the centre of the axis at right angles to its length. The position of this neutral point can in general be found with a maximum inaccuracy of a few per cent. by means of an ordinary charm compass. If d be the distance in cm. of the neutral point from either pole of the magnet, we have $\mu = \text{H}d^3$, where μ is the magnetic moment of the magnet and H the horizontal intensity of the earth's magnetic field. Knowing H, we can find μ with sufficient accuracy for most practical purposes. The compass should be first used to find out that the bar is magnetised uniformly. The needle must point parallel to the axis at the centre of the bar, and the poles must be equidistant from the ends of the bar. A. R.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

770. *New Method of Measuring the Total Quantity of Röntgen Rays emitted in a given Time.* **Gaiffe.** (Comptes Rendus, 142. pp. 447–448, Feb. 19, 1906.)—The method is based on the fact that the fluorescent properties of substances such as barium platinocyanide are diminished or destroyed by the action of the rays. Upon the surface of the pastille of this substance which is exposed to the source, discs of a radio-active matter of varying transparency to the rays are placed, leaving part of the pastille unprotected. The unprotected portion becomes rapidly darkened, while the covered areas change more or less slowly according to the degree of transparency of the protecting substance. It remains then to calculate, by other methods, the different quantities of Röntgen rays which will reduce each of the several covered portions to the same degree of dulness as the unprotected area, the distance from the source being constant. With these data the operator can at a glance determine the quantity emitted at any time during a *séance* without interrupting the administration, and without removing the pastille in order to examine it by daylight. H. W. P. Y.

771. *Physiological Action of Feeble Radio-activity.* **E. S. London.** (Archives d'El. Médicale, 14. pp. 94–101, Feb. 10, 1906.)—A specimen consisting of 18 mgm. of radium, applied to the skin of the forearm for brief intervals of time, was found to produce a reaction after a minimum exposure of 15 sec. duration. Three rabbits were confined in a cage 43 cm. long, 41 broad, and 31 cm. high. In the middle of the roof of the cage 260 mgm. of radium bromide were placed. Redness of the ears was observed after 16 days, and burns soon began to form on the skin of the back. After 14 months the backs and heads of the animals were denuded of fur and covered with ulcers. The animals had become apathetic and slow in movement, the hind legs were partially paralysed. Central retinitis was present in the eyes of all three and optic neuritis in one. The sexual instincts were abolished. Post-mortem examination revealed changes and degenerations in the muscles, liver, spleen, kidneys, and generative organs. H. W. P. Y.

REFERENCES.

772. *Field of a Rotating Electron.* **J. Geest.** (Phys. Zeitschr. 7. pp. 160–162, March 1, 1906.)—Following the work of Abraham, Sommerfeld, Lorentz, and Bucherer [see Abstract No. 1261 (1905)], the author here deals with a spherical rotating electron whose charge is uniform and of finite thickness, a surface charge, or a uniform charge throughout the volume. Expressions are obtained for the moment of the equivalent magnet and for the energies of the fields, external and internal. E. H. B.

773. *Dynamical Analogies of Electromagnetic Phenomena.* **G. Hilpert.** (Elekt. Bahnen, 4. pp. 41–45, Jan. 24; and pp. 61–68, Feb. 3, 1906.)—The author considers the dynamical analogues of self-inductance, resistance, capacity, &c., and works out a number of problems by the aid of approximate graphical methods. A. H.

774. *Note with reference to Weinberg's Memoir: Influence of the Medium on Mutual Actions of Currents and Magnets.* **N. Boulgakow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 37. No. 8. Physics Pt. pp. 213–220, Nov. 8, 1905.)—Weinberg has endeavoured to ascertain whether the supposition, that the constant l in the formula of Laplace-Biot-Savart depends on the properties of the medium, is true or not [see Abstract No. 1726 (1904)]. A mathematical discussion shows that this supposition is opposed to the principle of the continuity of the magnetic circuit. D. H. J.

775. *Influence of the Boundary of an Electrostatic Condenser.* **R. Magini.** (Accad. Lincei, Atti, 15. pp. 6–14, Jan. 7, 1906.)—Maxwell's equation for the width of additional strip to be added to a plane condenser plate in order to calculate its effective capacity is discussed; this varies with the thickness of the plate and also with the distance apart of the plates. The results are applied to certain cases of circular and elliptical condensers. S. G. S.

776. *Atmospheric Electrification.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2a. pp. 1377–1388, Oct., 1905. From the II. Phys. Inst. d. k.k. Univ., Wien.)—Continuation of series of articles on atmospheric ionisation, dealing with the genesis of the ions and their distribution per unit volume of air; the effect of radium emanations and radio-active matter. C. P. B.

777. *Recent Progress in Electric Lighting.* **P. Weiss.** (Soc. Franç. Phys., Bull. No. 2. pp. 267–301, 1905.)—A *résumé* from the non-technical standpoint.

778. *Ballistic Measurements with Damped Galvanometers.* **A. Bjerkén.** (Arkiv för Mat. Astron. och Fysisk, 2. No. 13. Elektrotechn. Zeitschr. 27. p. 226, March 1, 1906.)—A description of the calibration of a galvanometer for the purpose of measuring magnetic induction by the ballistic method when the damping is so great that the ordinary method is not convenient. S. G. S.

779. *Absolute Measurement of Capacity.* **H. Diesselhorst.** (Ann. d. Physik, 19. 2. pp. 382–394, Feb. 8, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—This paper, which is of a mathematical nature, is devoted to a consideration of Maxwell's formula for the absolute measurement of capacity. A comparison of the formula with that given by J. J. Thomson [Phil. Trans. p. 707, 1883] is made, and the corrections necessary for accurate work are considered. F. E. S.

780. *Franklin Röntgen-ray Electroscope.* (Röntgen Soc., Journ. 2. pp. 72–73, Feb., 1906.)—The apparatus consists of a single gold-leaf electroscope, the time of discharge of which is observed by means of a telescope. The rays enter through an ebonite window, giving rise to the ionisation which causes the discharge. No illustration is given. L. H. W.

781. *Duddell Thermo-galvanometer and Grassot Fluxmeter.* (Electrician, 56. pp. 559–560, Jan. 19, 1906.)—The Duddell thermo-galvanometer, the Ayrton-Perry-Duddell twisted strip ammeter [see Abstract No. 2690 (1904)], and the Grassot fluxmeter in their latest forms are illustrated and described, and the theory of the last named is given [see Abstract No. 1928B (1904)] in an article entitled "Some New Electrical Instruments."

782. *Recording Electrometer for Atmospheric Electric Measurements.* **H. Benndorf.** (Phys. Zeitschr. 7. pp. 98–101, Feb. 1, 1906.)—The latest form of the author's recording electrometer [see Abstract No. 576 (1903)] is fully described. The recorder is of the intermittent type, the pointer being depressed after equal time-intervals and making a mark by means of carbon paper. The theory and practical use of the instrument are also dealt with. L. H. W.

783. *The Hall-effect.* **T. C. McKay.** (Amer. Acad., Proc. 41. No. 17. pp. 385–395, Jan., 1906.)—Gives only titles of articles on the Hall-effect and on related phenomena.

784. *Measurement of Magnetic Constants.* **G. Meslin.** (Annal. Chim. Phys. 7. pp. 145–194, Feb., 1906.)—A fuller treatment of the papers separately dealt with in previous Abstracts.

785. *Magnetic Chart of British Isles.* **B. Baillaud** and **E. Mathias.** (Comptes Rendus, 142. pp. 555–559, March 5, 1906.)—Discussion of the methods of practical magnetic surveying, illustrated by a reduction of the actual values obtained by Rucker and Thorpe in their survey of the British Isles for 1886 and 1891, in which the method of districts was employed. A suggestion put forward by the authors connecting the distribution law for a central station with the law for regular distribution over the whole country is supported by the table given of computed and actually observed values. C. P. B.

786. *Medical Use of Statical Electricity.* **Bordier** and **Rouch.** (Archives d'Él. Médicale, 14. pp. 43–47, Jan. 25, 1906.)—When a bunch of couch grass, impregnated with a solution of an iron salt, is attached to the positive pole of a statical machine of sufficient power, iron is liberated in the atomic condition, and the authors suggest this as a possible means of treating tracheal or pulmonary disease. W. H. Si.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

787. *Distillation of Nickel, Iron, Manganese, Chromium, Molybdenum, Tungsten and Uranium.* **H. Moissan.** (Comptes Rendus, 142. pp. 425–430, Feb. 19, 1906.)—By means of the electric furnace and condensing arrangement used for the distillation of copper, gold, and the elements of the platinum group [see Abstract No. 401 (1906)] the author has distilled Ni, Fe, Mn, Cr, Mo, W, and U, employing currents of from 500 to 1,000 amps. at 110 volts. The most volatile of these elements is Mn, which distils more easily than chalk, Ni being next, and then Cr. Iron is more difficult to distil owing to a vigorous evolution of gas before boiling begins, but with a current of 1,000 amps., after the first effervescence, it distils fairly regularly. Uranium has a higher boiling-point than Fe, and requires a current of 700 amps., while Mo and W only distil with difficulty with currents of 700 and 800 amps. respectively, W having the highest boiling-point of the metals so far investigated. In each case the crystalline powder obtained by condensation of the vapour possesses the same chemical properties as the finely powdered metal. W. H. Si.

788. *Colouration of Gems by Radium Rays.* **A. Miethe.** (Ann. d. Physik, 19. 3. pp. 633–638, March 2, 1906.)—Glass is coloured brown or violet by radium rays [see Abstract No. 1103 (1905)]. The author studied the action of these rays on a large number of gems, and found that many of them are influenced by the rays. No general principles can be indicated, except that the more transparent gems show a greater tendency towards colouration than the opaque or highly coloured ones. The author used a preparation of 60 mgm. of radium bromide. A colourless diamond from Borneo was coloured a light yellow after 8 days, and a decided lemon-yellow after another 8 days. On heating the diamond to 250° the yellow colour was diminished, but it could not be entirely got rid of even at a red heat. A colourless Brazil diamond showed no colouration. A peculiar behaviour was shown by a pale blue sapphire from Ceylon. After only 2 hours' exposure to radium bromide it showed a colouration, green at first, then light yellow, and after a few more hours, reddish yellow. After a fortnight it was a dark yellow approaching chestnut. The colour could be got rid of by heating, but the light yellow colour always returned on cooling. Rubies show no change, and tinted tourmalines very little. Brazil tourmalines slightly coloured green and pink respectively at one end acquired the same colour at the colourless ends on exposure to radium. This colouration took a day or two to appear. E. E. F.

789. *Alteration in the Total Weight during Chemical Reactions.* **H. Landolt.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 8. pp. 266–298, 1906.)—The author has repeated some of his previous experiments, and carried out a number of new ones, to find out whether an alteration in weight occurs when a chemical reaction takes place, using more refined methods, and investigating fully the errors of experiment. A diminution in weight was observed in 42 out of 54 experiments, and an increase in weight in 12. The diminution depended largely on the reaction; in the case of the interaction between silver sulphate (or nitrate) and ferrous sulphate, it varied between 0·068 and 0·199 mgm., and between 0·047 and 0·177 mgm. in the reaction between iodic acid and hydrogen iodide. In other cases (iron and copper sulphate, gold chloride and ferrous chloride, iodine and sodium bisulphite, uranyl nitrate and potash, chloral hydrate and potash, ammonium chloride and water, potassium bromide and water, uranyl nitrate and water, copper sulphate solution and alcohol) the alteration in weight was hardly greater than the error of experiment, which was ± 0·03 mgm. Whenever an increase in weight took place it was always very small (0·002–0·019 mgm.) and less than the experimental error. No connection was found to exist between the formation or disappearance of electrons and the alteration in weight [R. v. Lieben, Abstract No. 1834 (1900)], as shown by the experiments in which the dissociation of the electrolytes altered during the reaction. The diminution in weight is in all probability real, since it only occurs to any great extent in a few reactions; if it occurred in all, it might be due to some unknown error of experiment. It is due, according to the author, to a slight disintegration of the atoms which takes place during the reaction (cf. Rutherford and Soddy's hypothesis with respect to the transformations which take place in radio-active elements), and the disintegrated particles escape through the walls of the reaction vessel (∩-shaped, and made of Jena glass). This is supported by the fact that in some experiments with silver salts and ferrous sulphate the inner sides of the ∩-tube were coated with a layer of paraffin wax, and the diminution in weight was then within the error of experiment. Quartz vessels were only used in a few cases, and the results obtained with them were not definite. Some experiments were also carried out in which a solution of cadmium iodide was subjected to electrolysis with alternating current (iodine alternately deposited and dissolved: platinum electrodes); no change in weight was observed. It is possible that the iodine atom in this process does not experience such a shaking as in the interaction between iodic acid and hydrogen iodide, and hence no disintegration occurs. The author offers no hypothesis as to the nature of the particles which escape from the tubes, but points out that electrons do not seem to be set free in chemical reactions, as shown by Campbell [see Abstract No. 1220 (1905)] and others. T. S. P.

790. *Properties of Mixtures of Nitric and Sulphuric Acids.* **A. V. Saposchnikoff.** (Zeitschr. Phys. Chem. 51. pp. 609–626, April 25, and 53. pp. 225–234, Sept. 19, 1905. Chem.-Laborat. der Artillerie-Akad., St. Petersburg.)—The densities and specific conductivities are given of mixtures in varying proportions of nitric acid of density 1·48 and sulphuric acid. A very small addition (5 per cent.) of nitric acid increases the conductivity of sulphuric acid ten times; this is due to the presence in the nitric acid of water, which produces the same effect. The vapour pressure of nitric acid of density 1·40, which has the value 1·9 mm. of mercury, is increased by the addition of sulphuric acid to a maximum of 23·43 mm. for a mixture containing 60·16 per cent. of sulphuric acid; a minimum pressure of 0·66 mm. is reached when the percentage of sulphuric acid present is 89·94. The proportion of nitrogen in the vapour for nitric acid of density 1·40 corresponds with the composition $2HNO_3$, H_2O; when 5 per cent. of sulphuric acid is present, the vapour has the composition HNO_3, which remains unchanged by subsequent additions of sulphuric acid. The density of the acid mixtures increases regularly with the proportion of sulphuric acid present until the latter reaches 90 per cent., and then falls slightly. The specific conductivity

falls regularly as the percentage of sulphuric acid rises from 0 to 70; beyond this a slight rise occurs, followed by a rapid fall to zero. [See also Abstract No. 2210 (1904).] T. H. P.

791. *Determinations of Osmotic Pressures of Solutions by Measurement of their Vapour Pressures.* **Berkeley** and **E. G. J. Hartley.** (Roy. Soc., Proc. Ser. A. 77. pp. 156–169, Feb. 8, 1906.)—The authors give the results of determinations of the osmotic pressures of cane-sugar solutions calculated from their vapour pressures—measured by a modification of Ostwald and Walker's dynamical method—by means of Arrhenius' well-known expression, $A\rho/\sigma . \log_e (p/p_1)$. The numbers obtained differ considerably from those determined directly. The authors show that in the above expression the density of the solution, σ, should be replaced by that of the solvent s, and, when this change is made the two sets of numbers are found to agree to within 5 per cent. [See also Abstract No. 2332 (1904) and next Abstract.] T. H. P.

792. *Relation between Osmotic Pressure and Vapour Pressure in a Concentrated Solution.* **W. Spens.** (Roy. Soc., Proc. Ser. A. 77. pp. 234–240, March 6, 1906.)—In deriving the equation giving the connection between osmotic pressure and solution, from a consideration of the equilibrium of a column of solution separated at the bottom from the pure solvent by a semi-permeable membrane, and placed in an atmosphere of vapour from the solvent, account must be taken of the fact that the concentration of the solution at the bottom and the top of the column is not identical, and also, in the case of concentrated solutions, there is a change of volume on mixing the solution with pure solvent. The author has now derived the following expression, by means of an isothermal cycle, for the osmotic pressure, viz.—

$$(P_2 + p) v_s - p' v_s + W - C\, aw/dc = \int_{p'}^{p} s\, dp,$$

where P_2 is the osmotic pressure corresponding to the concentration at the top of the column, p the vapour pressure of the solvent, v_s the increment in volume of a large mass of solution at a hydrostatic pressure p when unit mass of solvent is added, p' the vapour pressure of the solution, v_s same as v_s but applying to pressure p', W the work done in compressing unit mass from a pressure p' to a pressure $P_2 + p$; C is the concentration expressed as mass of solute in unit mass of solution. The above expression simplifies to—

$$P v_s = \int_{p'}^{p} s\, dp$$

and assuming Boyle's Law for the vapour, we obtain—

$$P v_s = sp \log p/p'.$$

When no change takes place when unit mass of solvent is added, *i.e.*, when $v_s = u =$ the specific volume of the solvent, then $Pu = sp \log p/p'$, which is the expression obtained by Berkeley and E. G. J. Hartley. [See preceding Abstract.] A. F.

793. *Method of Determining Specific Gravity of Soluble Salts.* **J. Y. Buchanan.** (Amer. Journ. Sci. 21. pp. 25–40, Jan., 1906. Paper read at meeting of the Chem. Soc. of London, April 6, 1905.)—The author describes the determination of the sp. gr. of halogen salts of the alkali metals, by means of the displacement of their mother-liquor (saturated at the temperature of the determination), and his results are given in a table. From his numbers he shows that the sp. gr. of the salts is a periodic function of the molecular weight. Further, the crystallisation of the cæsium salts from solution is accompanied by contraction, that of the potassium and rubidium salts by expansion. A. F

794. *Extraction of Carbon from Acetylenes and Metallic Carbides.* **A. Frank.** (Zeitschr. Elektrochem. 11. p. 769, Nov. 3, 1905. Paper read before the 77 Naturforscherversamml. at Meran, Sept. 24–30, 1905.)—On igniting a mixture of acetylene with either CO or CO_2 in closed steel vessels at an initial pressure of 6 atmos., pure carbon is formed according to the equations: (1) $C_2H_2 + CO = 3C + H_2O$; (2) $2C_2H_2 + CO = 5C + 2H_2O$. The first reaction appears to be reversible, since 2·5 equivalents of carbon were always obtained instead of 3. The acetylene may be replaced by a metallic carbide, the reactions then being—

$$(1)\ C_2Ca + CO = 3C + CaO\ ;\ (2)\ 2C_2Ca + CO_2 = 5C + 2CaO.$$

The graphite obtained has a density of 2–2·5, conducts well, and is especially suitable for sliding contacts. The decomposition of the carbides gives good results when applied to the hardening of soft iron, the "oxidation" or blackening of silver, &c. T. H. P.

795. *Reduction of Ferrous Oxide and the Three Forms of Carbon.* **R. Schenck** and **W. Heller.** (Ber. Deut. Chem. Gesell. 38. pp. 2132–2139, 1905.) **A. Smits.** (Ibid. p. 4027, 1905. Reviewed by Baur in Zeitschr. Elektrochem. 12. pp. 122–123, Feb. 16, 1906. Engineering, 81. p. 471, April 13, 1906.)—The reaction—

$$Fe + 3CO \longrightarrow FeO + 2C + CO_2,$$

is governed by a definite limiting pressure for each temperature, the values being determinable from the known values for the actions—

$$C + CO_2 \longrightarrow 2CO, \text{ and } Fe + CO_2 \longrightarrow FeO + CO,$$

or by direct experiment; the former method gave $P = 1$ atmo. at 775°, ½ atmo. at 675°, the latter method gave 685° and 650° respectively. The pressure of carbon monoxide produced by heating ferrous oxide and carbon with carbon dioxide (right-hand of equation) is affected by the form of carbon (sugar charcoal, diamond dust, or graphite) used, the graphite values agreeing most closely with those obtained when starting from iron and carbon monoxide (left-hand of equation); it is therefore probable that under these conditions the carbon is liberated in the form of graphite, and that the diamond and sugar charcoal persist only in a metastable condition. T. M. L.

796. *Influence of the Order of Additions to Steel upon its Solubility in dilute Sulphuric Acid.* **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 23. 6. pp. 292–298, 1905.)—Alloys of steel containing approximately 0·3 per cent. of carbon, with tungsten and aluminium, were prepared in two ways: in one case the steel was poured into a heated crucible containing both the tungsten and Al in a finely divided state, while in the other the tungsten alone was placed in the empty crucible and the Al added on finally filling up the

crucible, the amount of Al and tungsten used in both cases being the same. Small plates cut from the reguli found in each of the crucibles were exposed to dilute sulphuric acid (containing 1 per cent. of acid) for a total period of 288 hours, and the loss of weight determined at intervals. In all cases the material produced by adding the Al separately was found to be dissolved more rapidly. This result is tentatively ascribed to the partial oxidation of the tungsten in this material. W. Ros.

797. *Metallographic Method of detecting Counterfeit Coins.* **C. Hoitsema** and **W. J. van Heteren.** (Metallurgie, 3. pp. 128–130, Feb. 22, 1906.)—The counterfeit coins which are in the authors' experience the most difficult to detect are those "silver" coins whose chemical composition closely resembles that of the genuine coinage, but which have been produced by casting instead of by stamping from a rolled sheet. Illustrations are given of the structure of genuine coins of copper-silver, showing that the elongation of the crystals in the rolling of the sheets of metal is never quite obliterated by the subsequent annealing, so that the finished coin clearly shows this elongation, while a cast counterfeit shows no trace of such previous rolling. W. Ros.

798. *Calcium Alloys.* **L. Stockem.** (Metallurgie, 3. pp. 147–149, March 8, 1906. Communication from the Laborat. des Konsortiums für elektrochemische Industrie.)—Describes experiments which demonstrate that calcium cannot be alloyed with iron, the introduction of calcium into molten pig-iron, and into iron reduced by Al, failing to produce an alloy and only resulting in a slight decarburisation of the pig-iron. Iron oxide can be reduced by calcium and forms ductile beads of iron free from Ca, even when a large excess of Ca is used. Calcium-copper alloys are readily formed by pouring molten Cu into a magnesia-lined crucible containing fragments of Ca. Even small additions of Ca make copper brittle, an alloy containing 7 per cent. Ca being so brittle that bars 5 cm. thick can be broken by light taps with a hammer. The alloy containing 20 per cent. Ca is white and decomposes in air. The de-oxidation of copper by means of Ca can be readily carried out without risk of leaving Ca in the copper; an ingot of copper prepared by melting pure electro-copper in the blowpipe flame and subsequently de-oxidised by means of an addition of Cu-Ca alloy, was suitable for wire-drawing without further treatment. Mg and Al also form alloys with Ca in all proportions; both metals render Ca brittle, and an alloy containing 10 per cent. of either can be powdered in a mortar—where chemical purity is not essential this provides a means for obtaining Ca in a finely divided state. An Al-Zn alloy much used for electrical purposes has also been rendered tougher by the use of Ca for de-oxidisation. While Ca cannot be used in the production of steel, it is likely to become useful in the refining of copper and nickel. [See also Abstract No. 406 (1906).] W. Ros.

799. *Cementation by means of Gases and Vapours.* (Metallurgie, 3. pp. 123–128, Feb. 22, 1906. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—Bars of a pure variety of wrought iron were heated to known temperatures in an electric tube-furnace and exposed to currents of coal gas, petroleum vapour, acetylene, and carbon monoxide. The amount of cementation produced at temperatures from 600° to 1,200° C, after an exposure of 7 hours was determined in each case by analyses of

successive layers of material turned from the cylindrical bars, and the results were confirmed by examination of the microstructure. Cementation was observed in all cases except that of carbon monoxide, and the depth to which carbon had penetrated increased with the temperature employed; at the highest temperatures employed the cementation resulted in the formation of a species of cast iron, which melted. The results for each gas and temperature are shown in curves whose most striking feature is the rapid increase in the extent of cementation as soon as temperatures in the neighbourhood of 1,100° are reached. The authors find that cementation takes place at temperatures well below 700°, and confirm this result by specimens which have been exposed for prolonged periods to such low temperatures; the amount of carbon absorbed, however, appears to reach a limit which rises with increased temperature. In the authors' experiments the rods were always found to be coated with a deposit of solid carbon. W. Ros.

800. *A Modification of the van't Hoff Theory of the Lowering of Freezing-point.* **J. B. Goebel.** (Zeitschr. Phys. Chem. 53. pp. 213–224, Sept. 19, 1905.)—The author calculates interpolation-formulæ for the vapour-pressures of water and ice in the neighbourhood of 0° C. as functions of temperature. **K. Drucker.** (Zeitschr. Elektrochem. 11. pp. 904–905, Dec. 8, 1905.)—Drucker points out that, according to Goebel's calculation, the latent heat of melting of ice would vary nearly 300 per cent. between — 3° C. and 0° C.! It is shown that Goebel's error lay in the attempt to calculate accurate values of the heats of phase-transformation from vapour-pressure formulæ.

F. G. D.

801. *Phenomena occurring when the Plait-point Curve meets the Three-phase Line of a Dissociating Binary Compound.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 568–574, Jan. 10, 1906. Proc. 8. pp. 571–577, Jan. 25, 1906.)—An extension of the author's ether-anthraquinone results [see Abstract No. 1126 (1905)] to more complicated systems by the use of former investigations on *p.x.* and *p.t.* lines [see Abstract No. 1995 (1905)]. In cases of the CaO-CO_2 type there appear two critical points of $CaCO_3$ in liquid CO_2 with different concentrations, between which retrograde solidification must occur. In other cases the compound can only sublime when the melting-point of the compound is above the critical temperatures of the components; the line joining the eutectic points meets the plait-point curve four times. Examples of this should be obtainable, perhaps NH_3HCl. Curves are given showing conditions with varying concentration.

H. H. F. H.

802. *Measurement of Ionic Velocities.* **R. B. Denison** and **B. D. Steele.** (Roy. Soc., Phil. Trans. 205. pp. 449–464, March 12, 1906. Proc. Ser. A. 76. pp. 556–557, Dec. 6, 1905. Abstract.)—An apparatus is described for measuring or comparing the velocities of the ions of a salt without using gelatine or other partition during the experiment. It consists of two reservoirs, each supplied with a special electrode vessel, and of a measuring tube of known cross-section, in which is placed the solution under examination. The reservoirs contain solutions of salts, one with a slower kathion, the other with a slower anion, than that to be measured, and when a current is passed through such a system an electrolytic margin of constant velocity is formed. At each end of the measuring tube is provided a parchment-paper partition

which facilitates the production of a sharp margin between the indicator and measured solutions, and can be removed as soon as it is formed. The results obtained by the method agree closely with those calculated by Kohlrausch from conductivity data. W. H. Si.

803. *Heat of Neutralisation of Strong Acids and Bases and its Alteration with Temperature and Concentration.* **A. Wörmann.** (Ann. d. Physik, 18. 4. pp. 775–795, Dec. 12, 1905. Extract from Inaug. Dissertation, Münster, 1905.)—The heat of neutralisation depends largely on the temperature; between 0° and 32° the variation can be accurately expressed by the formula $s = s_0 - At$, *e.g.*, in the case of potassium chloride $s = 14759 - 46t$. The heat of neutralisation of the potassium salt is greater than that of the corresponding sodium salt, but the decrease with rising temperature is greater for the sodium than for the potassium salt; there is no marked difference between the nitrate and the chloride, but the former has the greater temperature-coefficient. Variations in the heat of neutralisation with concentration can only be detected in the more concentrated solutions; it appears to decrease rapidly from N to N/2 and then to remain nearly constant to N/12. T. M. L.

804. *Polymerisation of Liquids.* **P. Bogdan.** (Annal. Scientifiques de l'Univ. de Jassy, 3. pp. 223–237, Jan., 1906.)—The author gives a general discussion of the subject and concludes that the hypothesis of a polymerisation of the liquid molecules explains all the differences noted between van der Waals' theory and experimental results. All liquids are more or less polymerised—the polymerisation commencing even at the critical temperature and increasing with falling temperature; normal substances are also polymerised. It is impossible in the present state of science to calculate the degree of association. Eötvös' rule gives indications of the molecular constitution of liquids if we assume that in the case of ideal liquids K has a value greater than 3·7. In order to bring Longinescu's rule into line, the values of the constant C in the expression $\mathrm{T}/\mathrm{C}d = n^{\frac{1}{3}}$ must be altered so as to be applicable to the compound ethers experimented with. D. H. J.

805. *Ethylene Cyanide* (*Succinonitrile*) *as a Solvent and Ionising Medium.* **G. Bruni** and **A. Manuelli.** (Zeitschr. Elektrochem. 11. pp. 860–862, Dec. 1, 1905. From the allgem. Chem. Inst. d. Univ., Bologna.)—The molecular depression of the freezing-point (54·5°) of ethylene cyanide was found to be 182·6, an altogether exceptionally high value. Raoult has given the rule that the ratio of molecular depression to molecular weight is about 0·62; in some cases this ratio falls to 0·2 or 0·1, and in the single case of stearin to 0·053; in very exceptional cases it rises above unity, to 1·03 in the case of water and 3·14 in the case of phosphorus; ethylene cyanide gives the ratio 2·27. The latent heat of fusion calculated from the molecular depression by van't Hoff's formula is 11·75 cal. per kg., or 0·94 cal. per gm.-mol.; this value is much lower than the molecular latent heat of the majority of organic compounds, the values rising to 13·5 for the higher fatty acids and 40·9 for stearin, but never falling below 2·2; water gives the value 1·4, and nitric and sulphuric acids give values slightly below unity; the only substance that gives a lower value than ethylene cyanide is phosphorus, 0·15, the low latent heat of which is accompanied by an enormous velocity of crystallisation. No explanation is given of the abnormal properties of the cyanide. The isomorphous ethylene chloride and bromide give abnormally small

molecular depressions when dissolved in the cyanide. Low values are also given by hydroxyl- and amino-compounds, which appear to undergo association in this solvent. Potassium iodide and tetraethylammonium iodide, on the other hand, give abnormally high values, the *i*-values being about 1·8 in the former and 1·8 in the latter case; the solutions are, according to Walden, good conductors of electricity. T. M. L.

806. *Organic Solvents and Ionising Media.* II. *Measurements of Electrical Conductivity.* **P. Walden.** (Zeitschr. Phys. Chem. 54. pp. 129–230, Jan. 3, 1906. Phys.-chem. Laborat. des Polytechnikums, Riga, July, 1905.)—The electrical conductivity of tetraethylammonium iodide, $N(C_2H_5)_4I$, was determined in 49 solvents and over a range of dilutions, by means of which values could be determined for Λ_∞, the molecular conductivity at infinite dilution, and α, the coefficient of ionisation. This coefficient decreases in homologous series as the molecular weight increases, but increases in the series $CH_3.CO_2H$ (7 per cent.) ⟶ $CH_3.COCl$ (72 per cent.) ⟶ $CH_3.COCH_3$ (74 per cent.) ⟶ $CH_3.NCS$ (77 per cent.) ⟶ $CH_3.COH$ (84 per cent.) ⟶ $CH_3.OH$ (88 per cent.) ⟶ $CH_3.SCN$ (89 per cent.) ⟶ $CH_3.CN$ (90 per cent.) ⟶ $CH_3.NO_2$ (92 per cent.). There was found to be a direct relationship between the ionising power of the solvent and its dielectric constant as suggested by J. J. Thomson and by Nernst, but the relationship between the ionising power and the coefficient of association of the solvent postulated by Dutoit and Friderich was found not to exist. The values of Λ_∞ varied very widely in the different solvents, ranging from about 8 to 225; a mere measurement of the electrical conductivity at one dilution gives, therefore, no indication of the ionising power of the solvent. The value of Λ_∞ did not appear to be related in any way to the dielectric constant or to the coefficient of association of the solvent. Kohlrausch's law of the independent migration of the ions was verified for acetonitrile and for epichlorhydrin. The temperature coefficients of electrical conductivity were found to be positive in every case, and to range from 0·006 to 0·10, the highest values being observed in aromatic compounds. A direct relationship was found between the temperature-coefficients and the value of Λ_∞; a high coefficient corresponded always to a small Λ_∞, and the product with four exceptions lay between 1·00 and 1·65, the mean value being $\Lambda_\infty \times C = 1{\cdot}30$. The last relationship discovered was that if a series of different solutions of the same salt have the same coefficient of ionisation, then the product of the dielectric constant of the solvent by the cube root of the dilution of the solution is the same throughout, *e.g.*, if $\alpha = 0{\cdot}66$, then $\epsilon\sqrt[3]{v} = 124$, whilst if $\alpha = 0{\cdot}91$, then $\epsilon\sqrt[3]{v} = 368$. [See also Abstract No. 1146 (1904).] T. M. L.

807. *Electromotive Behaviour of Dilute Amalgams.* **J. F. Spencer.** (Zeitschr. Elektrochem. 11. pp. 681–684, Oct. 13, 1905. Anorg. Abteil. des Breslauer Universitätslaboratoriums, Aug., 1905.)—The amalgams used by the author were prepared by passing an accurately measurable current through cells of the form, mercury | metallic salt | metal, the potential of the amalgam towards a normal electrode being measured at the same time. Assuming the molecule of the metal dissolved in the mercury to be diatomic, amalgams of different concentrations exhibit differences of potential which agree well with those calculated from Nernst's formula in the cases of Zn, Cd, and Pb, but not with Tl or Cu. Concentrated amalgams of Zn and Cu are less noble, by several millivolts, than the pure metals. T. H. P.

808. *Potential of the Oxygen Electrode.* **G. N. Lewis.** (Amer. Chem. Soc., Journ. 28. pp. 158–171, Feb., 1906. Contribution from the Lab. of Phys. Chem. of the Massachusetts Inst. of Technology, No. 9.)—From the potential of the silver electrode in *n*-Ag solution, the decomposition-pressure of silver oxide and the solubility of silver oxide, the true potential at 25° of an oxygen electrode against normal hydroxyl ion is found to be —0·674 volt (the normal calomel electrode at 18° being taken as —0·560 volt). From this value, together with the value of the electrolytic dissociation of water, the true e.m.f. at 25° of the oxygen-hydrogen cell is calculated to be 1·217 volts, a value which is probably correct to within less than 1 centivolt. The temperature coefficient of the oxygen electrode is also calculated. A. F.

809. *Electrodeposition of Copper upon Iron.* **O. W. Brown** and **F. C. Mathers.** (Journ. Phys. Chem. 10. pp. 39–51, Jan., 1906.)—For depositing copper upon iron a bath containing 60 gm. of copper sulphate, 50 gm. of sodium hydroxide, 159 gm. of sodium potassium tartrate, and 1,000 c.cm. of water gives theoretical current efficiencies at both the anode and kathode and a bright, adherent deposit of copper. The best current densities are 0·1–0·5 amp. per sq. dm. of kathode and a maximum of 1·04 amps. per sq. dm. of anode. If a green precipitate begins to form on the anode, 3 or 4 gm. of sodium hydroxide per litre should be added. The use of potassium hydroxide and the warming of the bath are detrimental. Rolled, electrolytic, and cast copper anodes work equally well. The current efficiency for anode corrosion is theoretical if the anode discharge-potential has a value of *n* — 0·3 or less. T. H. P.

810. *Electrolytic Reduction of Succinimide.* **J. Tafel** and **B. Emmert.** (Zeitschr. Phys. Chem. 54. pp. 433–450, Jan. 30, 1906. Chem. Inst. d. Univ., Würzburg, Sept. 14, 1905.)—As regards the relations between useful effect, kathode potential, and concentration of the substance, the reduction of succinimide with lead electrodes proceeds in a more complicated way than that of caffeïn [see Tafel and Naumann, Abstract No. 905 (1905)]. This is due to two causes: (1) A specific catalytic action of the lead, which is especially strong with spongy lead; (2) a considerable rise of the acid-potential (kathode potential in the electrolysis of pure acid) produced by succinimide and its reduction product pyrrolidone. In the reduction of caffeïn with lead, the reducing power of the kathode (useful effect/concentration of substance) remains, in general, constant during an experiment, but with succinimide this reducing power increases, owing to a gradual change of the kathode by which the catalytic action of the lead is continually augmented. The reducing power of a lead kathode for succinimide increases with the concentration of the acid until the latter reaches 60 per cent., after which it falls. With caffeïn, however, this reducing power remains about constant while the acid concentration rises from 10 to 30 per cent., and subsequently diminishes. T. H. P.

811. *Electrolysis with Symmetrical and Unsymmetrical Alternating Currents.* **A. Löb.** (Zeitschr. Elektrochem. 12. pp. 79–90, Feb. 2, 1906. Communication from the Inst. f. phys. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—The results of the author's experiments on the electrolysis of potassium cyanide with copper electrodes, using both direct and alternating currents, are in agreement with those obtained by le Blanc and Schick

[Abstract No. 1238 (1904)]. The loss in weight of the electrodes increases with (1) the current density, (2) the concentration of the electrolyte, and (3) the number of edges and corners possessed by the electrodes, and diminishes as the number of alternations increases. Experiments are also described with zinc, nickel, and iron in potassium cyanide solution, and with lead in sulphuric acid solution. In the last case, when an alternating current is used, the lead dissolves with formation of lead sulphate and evolution of hydrogen. The amounts of lead dissolved and hydrogen evolved diminish as the number of alternations increases; with very low alternations—less than 2,000 per min.—the amount of action is also small, owing to the formation of a protecting layer of lead sulphate on the electrodes. Under some conditions copper becomes passive in normal potassium cyanide solutions, but the author gives no explanation of this phenomenon. When unsymmetrical alternating currents are used, theory requires that the increase in weight of one electrode should correspond with the loss in weight of the other. In sufficiently concentrated copper sulphate solutions this is found to be the case, but with a normal solution the hydrogen ions appear to take part in the electrolysis owing to the impoverishment of the electrode solutions in copper ions. In a 4*n*-solution of potassium cyanide the alterations in weight of the two electrodes differ by about 50 per cent., and the total loss of weight is about equal to that obtained with a symmetrical alternating current. Only those metals which are separated from their solutions in potassium cyanide by direct currents can be precipitated by hydrogen sulphide.
T. H. P.

REFERENCES.

812. *Atomic Weight of Nitrogen.* **R. W. Gray.** (Chem. Soc., Journ. 87. pp. 1601–1620, Oct., 1905.)—The author's determinations of the atomic weight of nitrogen by various methods lead to the following results: (1) From density of nitric oxide, 14·006; (2) from density of nitrogen, 14·008; (3) from gravimetric analysis of nitric oxide, 14·010. Giving each individual result an equal value, the final number obtained is 14·0085, which is in close agreement with the value, 14·0090, obtained by Guye [Abstract No. 2133 (1905)]. The author concludes that the true atomic weight of nitrogen correct to two places of decimals and referred to oxygen as 16 is 14·01. T. H. P.

813. *Density of Nitric Oxide and Atomic Weight of Nitrogen.* **P. A. Guye** and **C. Davila.** (Comptes Rendus, 141. pp. 826–828, Nov. 20, 1905.)—The weight of 1 litre of nitric oxide under normal conditions of temperature and pressure is found to be 1·3402 gm. [compare Gray, preceding Abstract] and the ratio $NO:O_2$, when corrected by physico-chemical methods, gives the atomic weight of nitrogen as lying between 14·006 and 14·010. T. H. P.

814. *Atomic Weight of Silicon.* **J. Meyer.** (Zeitschr. Anorg. Chem. 47. 1. pp. 45–55, Oct. 3, 1905.)—Taking the atomic weight of oxygen as 16 and that of chlorine as 35·47, the number obtained for silicon by Clarke, by Ostwald, and by the author is 28·25. [See also Abstract No. 1151 (1905).] T. H. P.

815. *Weights of Oxygen, Nitrogen, and Hydrogen.* **C. J. T. Hanssen.** (Chem. News, 92. pp. 172–173, Oct. 13, 1905.)—Making use of the experimental values obtained by Dewar, the author calculates the weights of 1 litre of liquid and solid oxygen, nitrogen, and hydrogen at different temperatures. T. H. P.

816. *Atomic Weights of Nitrogen* [*and Silver*]. **P. A. Guye.** (Chem. News, 92. p. 261, Dec. 8; pp. 275–276, Dec. 15; 285–287, Dec. 22, 1905; 93. pp. 4–5, Jan. 5; 13–14, Jan. 12; 23–24, Jan. 19; and pp. 35–37, Jan. 26, 1906. From Bull. Soc. Chim., 1905.)—The author discusses recent work on the atomic weight of nitrogen [see also Abstracts Nos. 2133 (1905) and 813 (1906)], for which he considers the value, 14·009, to be completely confirmed. This number, and also those for carbon and hydrogen, C = 12·002 and H = 1·0076, he regards as correct to 1 part in 10,000. Taking these values, the atomic weight of silver becomes not greater than 107·89. Other atomic weights are also affected. T. H. P.

817. *Atomic Weight of Bismuth.* **A. Gutbier.** (Zeitschr. Elektrochem. 11. p. 831, Nov. 24, 1905. Paper read before the 12 Hauptversamml. d. Deutsch. Bunsen-Gesell., Karlsruhe, June 1–4, 1905.)—As the result of a series of atomic weight determinations, the author finds for bismuth the atomic weight 208·03. A. F.

818. *Atomic Weight Determinations of Rare-earth Elements.* **O. Brill.** (Zeitschr. Anorg. Chem. 47. 4. pp. 464–476, Nov. 20, 1905. Inst. für. physikal. Chemie, Göttingen, March, 1905.)—The experiments were carried out with very small quantities of material (2–3 mgm.), the weighings being performed on Nernst's microbalance. The heating was effected by a platinum wire (resistance) furnace. F. G. D.

819. *Optical Rotatory Power of Nicotine.* **F. Ratz.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2b. pp. 777–788, July, 1905. From the chem. Inst. der k.k. Univ., Graz.)—By means described a specially pure nicotine was obtained, the optical rotation of which is about 8° greater than that obtained by Landolt. L. H. W.

820. *Density of Chlorine.* **F. P. Treadwell** and **W. A. K. Christie.** (Zeitschr. Anorg. Chem. 47. 4. pp. 446–454, Nov. 20, 1905. Analyt.-chem. Laborat. d. Polytechn. Zürich, Oct. 9, 1905.)—The mean value for the density, determined by Bunsen's method, is 2·489 at 10° and 725 mm. pressure. [Compare Abstract No. 408 (1904).]

821. *Segregation in Steel Ingots.* **B. Talbot.** (Iron and Steel Inst., Journ. 68. pp. 204–223; Discussion and Correspondence, pp. 224–247, 1905. Engineering, 80. pp. 462–463, Oct. 6, 1905.)—Deals chiefly with the advantages of a small addition of aluminium to the metal as it is run into the ingot, in reducing the segregation of sulphur, phosphorus, and carbon and consequently improving the uniformity of the ingot. L. H. W.

822. *Solubilities of the Isomeric Chromic Chlorides.* **H. W. Bakhuis Roozeboom** and **J. Olie, Jr.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 10–14, June 7, 1905. Proc. 8. pp. 66–70, Aug. 17, 1905.)—The authors have determined for the temperature of 25° the "curve of natural equilibrium" of the violet and green chromic chlorides in aqueous solution, and also the saturation-isotherms corresponding to the violet and green chlorides respectively as saturants. F. G. D.

823. *Molecular Refraction and Dispersion of Acetylenic Compounds.* **C. Moureu.** (Comptes Rendus, 141. pp. 892–895, Nov. 27, 1905. Annal. Chim. Phys. 7. pp. 536–567, April, 1906.)—A table is given of the optical coefficients of 30 compounds containing the group $-\mathrm{C} \vdots \mathrm{C}-$. The normal increase of molecular refraction by each triple linkage is 2·319; in the case of diphenyldiacetylene $\mathrm{C_6H_5 . C \vdots C . C \vdots C . C_6H_5}$ the excess rises to 17·494, or 12·856 above the normal increase—a remarkable example of the co-operative effect of adjacent negative groups. T. M. L.

824. *Chemical Separation of Radio-active Matter from Thorium Compounds.* **H. Schlundt** and **R. B. Moore.** (Journ. Phys. Chem. 9. pp. 682–706, Nov., 1905.)—An expanded account of a paper which has already been abstracted. [See Abstract No. 1653 (1905).] R. S. W.

825. *Flowing Crystals* [*Trichites*]. **O. Lehmann.** (Ann. d. Physik, 19. 1. pp. 22–35, Jan. 18, 1906.)—Deals with the properties and behaviour of trichites of *p*-azoxycinnamicethylester (abnormally formed, long, thin, hair-shaped, quickly-growing crystals which form at the side of normal crystals and often, suddenly becoming thicker, grow into normal crystals). [See also Abstracts Nos. 514 and 645 (1906).] L. H. W.

826. *Application of Thermic Analysis.* III. **G. Tammann.** (Zeitschr. Anorg. Chem. 47. 3. pp. 289–313, Nov. 9, 1905. Inst. f. anorgan. Chem. der Univ., Göttingen.)—The author extends the method discussed in his two previous papers [Abstracts Nos. 207 (1904) and 1516 (1905)]. It consists in determining temperature-time cooling curves for a series of melts of varying composition, and in deducing therefrom the nature and composition of the phases which are crystallising out. The present paper contains a theoretical discussion, by means of phase-diagrams, of various possible cases. The method is of particular importance in dealing with high-temperature reactions. F. G. D.

827. *Calorimetric Measurement of Heats of Combustion.* **W. Jaeger** and **H. v. Steinwehr.** (Zeitschr. Phys. Chem. 53. pp. 153–165, Sept. 19, 1905. Communication from the Physikal.-Techn. Reichsanstalt.)—The authors discuss several questions bearing on the measurement of heats of combustion by means of a calorimetric bomb. Platinum thermometers are recommended in preference to mercury ones for calorimetric measurements [see Abstracts Nos. 1217 (1903)] and 808 (1904)]. The results obtained by Fischer and Wrede [see Abstract No. 2214 (1904)] are about 0·25 per cent. too high. T. H. P.

828. *Heat of Formation of Certain Silicates.* **D. Tschernobaeff.** (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 729–736, Aug., Sept., Oct., 1905.)—The author gives the heat evolutions of several reactions between carbonates of Ba, Ca, Sr, and Na and silica, obtained by burning the reacting compounds, mixed with carbon, in a calorimetric bomb. The heats of formation of the calcium aluminates from calcium carbonate and alumina are: Al_2O_3, CaO, —44·7 Cals.; Al_2O_3, 2CaO, —87·0 Cals.; Al_2O_3, 3CaO, —132·5 Cals. The heat of transformation of quartz into fused silica is —0·9 Cals. per mol. T. H. P.

829. *Reversible Photochemical Reactions in Homogeneous Systems. Anthracene and Dianthracene.* II. **R. Luther** and **F. Weigert.** (Zeitschr. Phys. Chem. 53. pp. 385–427, Oct. 20, 1905. Physikal-chem. Inst., Leipzig, July, 1905.)—The authors have continued the study of the conversion of anthracene into dianthracene under the influence of light [see Abstract No. 2154 (1904)]. As the result of their experiments the authors conclude that the Wittwer-Nernst formula—

$$v = \mathrm{KIC}_1{}^{n_1}\mathrm{C}_2{}^{n_2} \ldots - \mathrm{K}'\mathrm{C}_1'{}^{n_1'}\mathrm{C}_2'{}^{n_2'} \ldots.$$

does not represent the results of their investigation, and they derive a formula for their results. To obtain a quantitative agreement between their theory and their experimental results, the authors assume the existence of light-absorbing intermediate substances. The authors conclude with a mathematical discussion of the problem of reversible photochemical reaction. A. F.

830. *Oxidation of Palladium.* **L. Wöhler.** (Zeitschr. Elektrochem. 11. pp. 836–844; Discussion, p. 844, Nov. 24, 1905. Paper read before the 12 Hauptversamml. d. Deutsch. Bunsen-Gesell., Karlsruhe, June 1–4, 1905.)—Tables and curves are given showing the relation between the temperature and pressure of palladium oxide when heated in a previously evacuated space. When the temperature is maintained for some time at 877°, corresponding with a pressure of 771 mm., the oxide undergoes a change to which the author gives the name "degeneration"; on then cooling, it is found that the original correspondence between temperature and pressure no longer holds. The heat of formation of the oxide, calculated by means of van't Hoff's equation, diminishes with rise of temperature, the mean value between 711° and 866° being 23·5 Cals. With platinum, the phenomenon of degeneration is more marked than with palladium. T. H. P.

831. *Reciprocal Pairs of Salts.* IV. *An Affinity Problem.* **W. Meyerhoffer.** (Zeitschr. Phys. Chem. 53. pp. 513–603, Nov. 7, 1905.)—A long paper, unsuited to efficient abstraction and divided into the following heads: Introduction. 1. Discussion of the stability of $BaSO_4 + K_2CO_3$ and of $BaCO_3 + K_2SO_4$ according to observations already made. 2. Direct proof of the stability. 3. Solubility determinations. 4. Discussion of the solubility data: (1) Isotherms; (2) Polytherms; Guldberg and Waage's surfaces; (3) Cryohydric limits of Guldberg and Waage's surfaces. 5. Guldberg and Waage's researches. 6. Dulong's researches. 7. Heinrich Rose's researches. 8. Analysis of a mixture of the four solid salts by means of triad-solutions. 9. Malaguti's researches. 10. Periodic, supersaturation and adsorption phenomena. 11. Fractional precipitation. 12. *Résumé.* T. H. P.

832. *Heterogeneous Catalytic Reactions.* III. *Influence of Silica on the Reaction,* $2CO + O_2 = 2CO_2$. **M. Bodenstein** and **F. Ohlmer.** (Zeitschr. Phys. Chem. 53. pp. 166–176, Sept. 19, 1905.)—This reaction is accelerated catalytically when it proceeds in a vessel of quartz-glass, the velocity being represented by the expression: $dx/dt = k(m + a - x)/(n + b - x)$, where a and b are the initial concentrations of oxygen and carbon monoxide respectively, and m and n are constants. Carbon monoxide has a negative autocatalytic effect, retarding its own combustion in the quartz-glass vessel, so that the velocity of the reaction is almost inversely proportional to the concentration of this gas. [See also Abstracts Nos. 932 and 2052 (1904).] T. H. P.

833. *Rate of the Reaction between Arsenious Acid and Iodine in Acid Solution.* II. **J. R. Roebuck.** (Journ. Phys. Chem. 9. pp. 727–763, Dec., 1905.)—The experiments previously described did not give a close agreement between the equilibrium-constant in the action $H_2O + H_3AsO_3 + I_2 = H_3AsO_4 + 2HI$ and the ratio of the velocities of the direct and reverse actions [see Abstract No. 144 (1903)]. This deviation is now attributed to disturbing influences in the reversed action, and the two values are brought to agree within about 6 per cent. T. M. L.

834. *Ozone.* **S. Jahn.** (Zeitschr. Anorg. Chem. 48. 3. pp. 260–293, Feb. 15, 1906. Phys.-chem. Inst., Göttingen, Dec., 1905.)—The author shows that the velocity of decomposition of ozone increases proportionally with decrease of the pressure. This result is explained by assuming that the decomposition occurs in stages, and that what is measured is the velocity of the second step, which is represented by the equation: $O + O_3 = 2O_2$. T. H. P.

835. *Equilibria in Pseudo-binary Ternary Systems; Application to Explain Anomalous Fusion and Solution Phenomena.* **H. W. Bakhuis Roozeboom** and **A. H. W. Aten.** (Zeitschr. Phys. Chem. 53. pp. 449–501, Oct. 20, 1905.)—A general discussion of the equilibria obtained in these systems. A. F.